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Observations on Mr. Ellwood Morris' Remarks on Water-Wheels. By Mr. James Whitelaw.

From the Glasgow Practical Mechanic and Engineer's Magazine.

In Vol. II., pp. 221—224, of your Magazine, you have printed part of an article, written for the *Journal of the Franklin Institute*, by Mr. Ellwood Morris, C. E., entitled, "Remarks on Re-action Water-Wheels used in the United States, and on the Turbine of Fourneyron, an Hydraulic Motor, recently used with the greatest success on the continent of Europe." When I read the portion of Mr. Morris' paper referred to, I felt satisfied that his notions on many of the subjects which he had taken in hand to discuss, were incorrect; and, at the time, intended to show where he was in error; but my attention at the time being otherwise engaged, I deferred to write, and latterly, on reconsidering the matter, it occurred to me that it would be advisable to reserve my remarks till after I had read the remaining part of the paper. But as Mr. Morris' remarks on Turbines have not, up to the present time, appeared in your pages, I recently applied for, and obtained the numbers of the *Journal of the Franklin Institute* in which they are printed; and, as their perusal has not changed my opinions, I shall proceed to notice some points of the subject which Mr. Morris has undertaken to handle, without, seemingly, an adequate knowledge of the principles involved.

I may state, in the first place, that Mr. Morris has sadly undervalued the experiments of Smeaton, on overshot water-wheels, and

has attempted to give to the experiments, made by the Franklin Institute, an importance which they do not deserve. The following quotation from the paper of Mr. Morris, will, in some measure, serve to explain this: "The *coefficient of effect* of wheels of the first class [overshot water-wheels] is assumed, for our present purposes, at 0.700 to 0.800, in consequence of the able experiments of the Franklin Institute having shown, that, under favorable circumstances, even *eighty-four per cent.* of the power expended may be realized by overshot wheels, whilst Smeaton's experiments developed a ratio of power and effect of 3 : 2, giving 0.666 for the coefficient of effect."

It may be true that the Franklin Institute have shown, that "under favorable circumstances" even eighty-four per cent. of the whole power of the water may be obtained by overshot wheels; but Smeaton's experiments also prove that an overshot wheel is capable of giving as high a result. Mr. Morris will find this to be the case should he take the trouble to turn up p. 37, and consult table 2, of *Tredgold's Tracts on Hydraulics*, published in the year 1836, by Mr. Taylor, of London. I shall take the experiment marked No. 3, in the table to which I refer, to illustrate, and bear me out in this statement. The experiment is recorded in the following tabular form:—

No. of experiment.	Whole descent.	Water expended in a minute.	Turns at the maximum in a minute.	Weight raised at the maximum.	Power of the whole descent.	Power of the wheel.	Effect.	Ratio of the whole power and effect.	Ratio of the power of the wheel and effect.	The diameter of the water-wheel is 24 inches.
	Ins.	Lbs.		Lbs.						
3	27	$56\frac{3}{4}$	$20\frac{3}{4}$	$12\frac{1}{2}$	1530	1360	1167	10 : 7.6	10 : 8.4	

Now, this is a result of 84 per cent., in other words, a coefficient of effect = 0.84, which is the same as that which Mr. Morris informs us was obtained by the Franklin Institute.

It is true that I have here taken the case where the height of the head of water, which is above the water-wheel, is subtracted from the whole height of the fall; and I believe that the Franklin Institute, in the experiments referred to by Mr. Morris, calculated the coefficient of effect from the power produced by the whole descent of the water. But the height of the head of water above the wheel being only a very small fraction of the whole descent, when the fall is high, and, especially, when the water-wheel is broad, and has narrow shrouding, Mr. Smeaton's experiment may be reckoned, with all fairness, to give to the coefficient of effect (0.84) a value which may be considered correct for practical purposes.

Did I think it necessary for my purpose, I might extract from Mr. Smeaton's papers many examples of a different kind, to prove that Mr. Morris did not understand his subject when he wrote his "Remarks;" but I conceive that nothing further is required to bear me

out than the general statement, that in *every case* Mr. Smeaton's experiments gave a higher result than 66.6 per cent., even when he calculated the power from the whole descent. In the very experiment above quoted, the result, it will be observed, is 76 per cent.

I have neither seen a drawing, engraving, nor description of the apparatus which was used by the committee of the Franklin Institute in their experiments on water-wheels; but from specimens of their mode of reducing the results, which are in my possession, I am led to believe that their apparatus was complicated and clumsy, compared with that used by Smeaton, and am, therefore, inclined to think that the experiments of the former, though made on a large scale, are not more to be depended on than those of Smeaton, which were performed on a small machine. It is worthy of remark, that Mr. Smeaton did not allow enough for the friction of his model, else his experiments would have given to the coefficient of effect a value somewhat higher than they have done. And I may state further, that the Franklin Institute had money at their command, and Mr. Smeaton, though not assisted in that way, made experiments which the Franklin Institute could do no more than repeat; and, besides, Mr. Smeaton by his experiments, explained important laws, a knowledge of which is necessary to every mechanic, and especially to every one who attempts to discuss hydraulic motors.

Below I shall give the results of a few experiments, for the purpose of convincing Mr. Morris that he knows very little about the theory of re-action water-wheels. How he made up his mind to class *re-action wheels* with those of *impulse* (undershot water-wheels) puzzles my comprehension, as it appears to me that a good re-action wheel is as much a *wheel of pressure* as an overshot water-wheel is. Mr. Morris may have been led into error by the experiment which he made on something like a re-action wheel, but which is no more to be considered such, than the toy which children play with, composed of a small slip and rod of wood, a pin, and two D-shaped pieces of paper, is to be reckoned a wind-mill. Moreover, as an engineer, he should have known, that he could not, from his experiment, arrive at the true value of the coefficient of effect for re-action wheels.

I will not occupy your pages by explaining the theory of re-action wheels; but will, instead, furnish you with the results of some experiments, to prove that for any purpose where a usual degree of speed is required, the kind of re-action wheel which I invented, has, for its coefficient of effect, a value as high as that of an overshot wheel—and that .35 to .40 does not, as Mr. Morris supposes, represent the efficiency of a re-action water-wheel, any more than it does the specific gravity of the moon.

The following results were calculated by Mr. Randolph, from a series of experiments performed by him on a new water-mill, which he erected lately at a factory situated near Glasgow. At the factory there is a steam engine just powerful enough to drive the whole of the machinery, and the power of the water-mill is not so great as that of the steam engine. The water-mill and steam engine can be worked either separately, or together, at any time. The power of the mill

was determined by applying a Watt's indicator—of the kind made by Mr. M'Naught—to the steam engine, when working under different pressures of steam. This mode of testing will be readily understood from what follows.

The diameter of the cylinder of the steam engine is 31 inches, and the length of stroke 5 feet.

The water-mill has a fall of 15 feet, and uses 2000 cubic feet of water per minute. By taking .75 for the coefficient of effect, the power of the water-mill would thus be equal to that of 42 horses.

Results of Experiments.

1. Steam engine, working alone, at 24 revolutions per minute—mean pressure of 3 diagrams = 1.626 lbs. per square inch.
2. Steam engine, driving whole factory, at 23.5 revolutions per minute—mean pressure of 2 diagrams = 12.275 lbs. per square inch.
3. Steam engine, driving whole factory, at 22.5 revolutions per minute—mean pressure of 4 diagrams = 12.4 lbs. per square inch.
4. Steam engine, assisting water-mill, at 23 revolutions per minute—mean pressure of 3 diagrams = 3.9 lbs. per square inch.
5. Steam engine, assisting water-mill, at 22.75 revolutions per minute—mean pressure of 4 diagrams = 3.72 lbs. per square inch.

From these data we readily arrive at the following results, by the mode of calculations indicated:—

No. 2. minus No. 1. = (12.275 — 1.626) lbs. = 10.649 lbs. effective pressure on cylinders when the steam engine is driving the whole factory at 23.5 revolutions.

No. 4. minus No. 1. (= 3.9 — 1.626) lbs. = 2.274 lbs. effective pressure on cylinders, when steam engine is assisting water-mill at 23 revolutions.

And (10.649 — 2.274) lbs. = 8.375 lbs. pressure, which gives to the water-mill a power equal to that of 45 horses, and, making the deduction according to M. Morin, for the additional friction of the engine when loaded, this becomes 41.63 H. P.

No. 3. minus No. 1. = (12.4 — 1.626) lbs. = 10.774 lbs. effective pressure on cylinder, when steam engine is driving the whole factory at 22.5 revolutions.

No. 5. minus No. 1. = (3.72 — 1.626) lbs. = 2.094 lbs. effective pressure on cylinder, when steam engine is assisting water-mill at 22.75 revolutions.

And (10.774 — 2.094) lbs. = 8.68 lbs. pressure, which gives to the water-mill a power equal to that of 44.6 horses, and deducting, as before, for the additional friction of the engine, this shows an available power of 41.26 horses.

The mode of testing, here adopted, is, perhaps, the most direct, and therefore, the most to be relied upon of any which could be applied, and shows, practically, that the coefficient of effect does not fall appreciably short of 0.75.

In the two series of experiments which follow, the power of the water-mill was tested by means of M. Proney's brake, and the water expended was accurately measured in a box.

The diameter of the water-mill is only 7¼ inches.

The length of the arm of the friction brake, in feet, is

$$\frac{10}{8.1416+2}$$

The experiments were made by Messrs. Randolph and Cunliff, of Glasgow, and myself.

RESULTS.—1. SERIES.

Height of fall in feet.	Cubic feet of water per minute.	Revolutions of the water-mill per minute.	Weight on the friction brake.	Power in per cents.
10.42	10.95	813	10 oz.	71.5
10.32	10.9	800	10 oz.	71.3
10.23	10.76	792	10 oz.	72.2
10.13	10.6	778	10 oz.	72.7
10.06	10.4	730	10 oz.	70.7

RESULTS.—2. SERIES.

9.84	10.87	813	9½ oz.	70.5
9.64	10.6	783	9½ oz.	71.1
9.52	10.4	768	9½ oz.	72.0
9.38	10.28	755	9½ oz.	72.6
9.33	10.12	730	9½ oz.	71.7

Messrs. Escher, Wyss & Co., of Zurich, Switzerland, and Mr. John Hamilton of the same place, have obtained a result of about ⅘ths of the power of the water from a number of water-mills which they have erected on low falls; and, along with others, I have obtained from a water-mill, which was tested by the friction brake, a result of 78 per cent. of the power of the water.

As Mr. Smeaton, and, I believe, the Franklin Institute, have considered the power required to overcome the friction of the gudgeons, and the resistance which the atmosphere offers to the motion of the water-wheel, part of the effect—I might have done so too, and thus have increased the above results, which give the actual, or available, power of the water-mill, and nothing more; but by reckoning up, with the power, the quantity consumed in working the machine itself, a result greater than what the machine can give out to work machinery is obtained,—which does not seem to me altogether correct, or fair. I should, however, observe, in relation to the preceding results, that I do not expect the same per centage from a model of the size from which they were obtained, as from a larger sized machine.

Mr. Morris, had he studied his subject a little more closely, would not have so hastily arrived at conclusions grounded upon first notions —he would not have allowed himself to be deceived by appearances,

which are almost inseparable from a machine of such construction as that of the turbine of M. Fourneyron. For example, he ought not to suppose, when he sees the water falling directly downwards from that machine, when in motion, that the fluid has spent all its force before leaving the orifices. For it is possible, and, indeed, very likely to be the case, that the water outside, and close to the turbine, is deprived of a great portion of its force, by adhering to the inclined exterior surfaces of the water passages in the revolving part of that machine. The water may adhere to the edge of the turbine, for the same reasons that Hall's hydraulic belt lifts water; and, therefore, the machine may be deprived of a large amount of its power, by simply acting against the force of the escaping water, thereby bringing it nearly, or altogether, to a state of rest, or even, in some cases, entirely reversing its motion.

From this remark, Mr. Morris will see how it is possible that the turbine may be improved; and, I may remark further, for his benefit, that the turbine, in some of its best forms, is neither more, nor less, than a very complicated re-action water-wheel; still further, that my water-mill is, from its superior simplicity and efficiency, fast superseding the use of the turbine on the continent of Europe. Messrs. Escher, Wyss & Co., of Zurich, have lately taken down five new turbines, and replaced them with the new water-mill—and these gentlemen, and other engineers of eminence, a few months ago, tested, by means of Proney's brake, several turbines, and did not obtain from one of them any thing like so high a result as Mr. Morris says may be realized by that hydraulic motor.

Mr. Morris is, I dare say, a gentleman of talent, and should he take the trouble to study his subject before putting it on paper, may become an honor to his country; but if he persist in the incautious course, which he seems to have laid out for himself in his "Remarks," he will, to a certainty, deserve to be classed amongst those edifying authors who write stories about the "Great Sea Serpent,"—and may find a companion in him who told us lately that the "almighty particular riot" of the Falls of Niagara had been quashed in the twinkling of an eye.

Paisley, 22d March, 1844.

Remarks on the above Letter. By Ellwood Morris, C. E.

The mere fact of the above letter having found a place in the Glasgow "*Practical Mechanic and Engineer's Magazine*," imparts to it an air of respectability, which will, I hope, justify me in noticing a few of its misstatements.

My former remarks in this Journal on "*Re-action Water-Wheels used in the United States, &c.*," were merely designed to throw into a condensed form such popular information, relative to water-wheels, as would enable the general reader to compare, without trouble, the relative merits of the well known family of re-action water-wheels, in common use here, and of the turbine of Fourneyron, just then being introduced in America.

In every conclusion, that was therein drawn, I am fully sustained by the practice of the country, with the re-action water-wheels referred to.

I did not allude to the water-mill of Whitelaw and Stirratt, simply because it did not come within the scope of my design, and, certainly, I had no idea that such omission would draw down upon me the assault of an individual whom I neither thought of at the time, nor could, for a moment, have regarded as an authority of such weight in hydraulic affairs, as to require propitiation.

Tredgold's Tracts on Hydraulics, (from which Mr. Whitelaw quotes,) are well known in this country; and, it so happens, that from Smeaton's "*Observations and Deductions*," therein recorded, on page 38, I drew the statement that his experiments gave 0.666, as the coefficient of effect of an overshot water-wheel. On the page referred to, Mr. Smeaton says:—

"The effective power must be reckoned from *the whole descent*. . . . . The ratios between the *powers*, so estimated, and the *effects* at the *maximum*, deduced from the several sets of experiments, are exhibited in one view, in column 9, of table 2; and from hence it appears, that those ratios differ from that of 10 to 7.6, to that of 10 to 5.2; that is, nearly from 4 : 3 to 4 : 2: . . . . . *by a medium of the whole the ratio is that of* 3 to 2, *nearly*."

Now the ratio of 3 *to* 2, *certainly gives* 0.666, *for the coefficient of effect, as was stated by me.*

The single experiment quoted by Mr. Whitelaw, was clearly regarded, by Smeaton, as insufficient to establish a coefficient of 0.84, or even 0.76, for overshot water-wheels in practice, and, however highly the former may estimate his own capacity to generalize the results of those celebrated experiments, the rest of the world, will, probably, agree with me, that it is infinitely inferior to that which adorned the illustrious Smeaton himself.

The experiments made upon water power, by the Franklin Institute, having already received the sanction of the highest authorities in hydraulic science, it would be wasting space to defend them against such an assailant as Whitelaw, especially as the latter, whilst (with rare assurance,) pronouncing their apparatus "complicated and clumsy," declares, in the same breath, that he has "neither seen a drawing, engraving, nor description" of it!

Notwithstanding Mr. Whitelaw professes great ignorance relative to the experiments of the Franklin Institute, it is a singular fact, that under date of June 5th, 1832, he wrote, from New York, a letter to the editor of the Journal of the Franklin Institute, on the subject of water-wheels, which was published in the August number for that year, (see Journ. Frank. Inst. for 1832, vol. x, p. 73.)

This letter described the principle of the improvements made in Barker's mill, by curving its arms, which are now known here as the "Scotch motor," and in Europe as "Whitelaw and Stirratt's patent water-mill;" and, we may here remark, in passing, that under our patent law, this letter will prevent him, or his agents, from securing

to themselves, by letters patent, subsequent to August, 1832, any thing which is described in his "*printed publication*" of that date.

In this same tenth volume, containing the letter spoken of, a number of the experiments of the Franklin Institute, on water power, are described, and drawings, of part of the apparatus used, are given.

The Journal of the Franklin Institute, was, therefore, so familiarly known to Mr. Whitelaw, in 1832, that he was one of its correspondents:—the report on water power formed, at that time, a prominent portion of its contents, and yet he pretends ignorance of that report!

In Mr. Whitelaw's letter published above, he makes an assertion, which, if it be a fair specimen of the dependence to be placed on his allegations generally, would inscribe him very low, indeed, upon the roll of truth.

It will be seen that he alleges, unequivocally, "*that* IN EVERY CASE *Mr. Smeaton's experiments gave a higher result than* 66.6 *per cent., even when he calculated the power from the whole descent.*"

This is certainly erroneous, and displays, on Mr. Whitelaw's part, a lamentable ignorance of the contents of the book he had before him, as is proven by the paragraph already quoted from page 38 of *Tredgold's Tracts*, and by the 9th column of Smeaton's table 2, page 37, which we give below, to wit:—

Number of Experiments.	Ratio of the whole Power and Effect.
1	10 : 6.9
2	10 : 6.9
3	10 : 7.6
4	10 : 7.3
5	10 : 7.3
6	10 : 7.0
7	10 : 6.8
8	10 : 6.5
9	10 : 6.6
10	10 : 6.5
11	10 : 6.6
12	10 : 6.1
13	10 : 5.9
14	10 : 6.5
15	10 : 5.9
16	10 : 5.2

Now, it appears from the above 9th column of the table quoted, that so far from Smeaton's experiments giving a higher result than 66.6 per cent., "*in every case*," as Mr. Whitelaw has asserted, *seven out of the sixteen experiments tabulated, actually give results much below that limit!*

After having thus exposed this misrepresentation, upon which Mr. Whitelaw has chosen, in specific terms, to rest his case, I will conclude, by observing, that the accuracy of the results obtained from the Turbine of Fourneyron, rests upon the safe authority of MORIN, and other distinguished French philosophers, whose names will live in the archives of science, when that of Whitelaw shall have passed into deserved oblivion.

On the Pyramids of Egypt. *By* J. J. Scoles, Esq., M.I.C.E.

(Continued from page 12.)

The pyramid of Meydoom is called the false pyramid, because the base is supposed to have been formed out of a knoll of rock, and it certainly has that appearance. The base is about 530 ft. square, and 124 ft. 6 ins. high. It is formed in three degrees, each having the form of a truncated pyramid, at an angle of 74° 10′. The blocks are of compact limestone 2 ft. thick; they are laid at right angles to the external face, and have been worked and put together with great skill. The entrance was not discovered. Mr. Perring thinks the whole has probably been covered with large unsquared blocks, so as to complete the shape of a regular pyramid. The appearance is very striking from the river, and particularly commanded the attention of Mr. Scoles, and his fellow travelers, in passing up the Nile.

The Illahoon pyramid is built round the knoll of a rock, which is nearly 40 ft. higher than the base; the rock has been faced with crude bricks, and a superstructure has been erected over it, composed of the same material, and supported by walls of stone which proceed from the centre of the edifice. The bricks are laid in a mortar formed of Nile earth, as high as the walls extend, and above them in gravel. They measure $16\frac{3}{8}$ ins. by $8\frac{3}{8}$ ins., and about $5\frac{1}{2}$ ins. in thickness, are well worked, and are formed of Nile earth, mixed up with various proportions of chopped straw, and are marked with the fingers as at Dashhour.

Another ruined brick pyramid exists at Howarah; the bricks laid in fine gravel. No entrance to it has been discovered. There are three other pyramids, two at Biahhmo, and one at El Koofa, both built of stone, but of small dimensions.

Most of the pyramids have been connected with the plain by inclined causeways formed of large blocks of stone, some with a parapet wall on each side. These inclined roads were, no doubt, originally constructed for the conveyance of the stone, and of the other materials used in the erection of the pyramids, but they seem afterward to have constituted the regular approaches. Herodotus mentions that they were adorned with the figures of animals, which were probably either sculptured hieroglyphics, or an avenue of sphinxes; and at Abouseer fragments of black basalt, at nearly equal distances, were found on the causeway. Pavements about two feet in thickness extended around the buildings, and where the rock was low the pavement was placed upon a layer of sand.

The pyramids correspond in their general arrangement; with one exception, their sides are placed exact to the cardinal points, and in the excepted one the difference is only 4° 35′; the entrances are on the north side, (the pyramid at Sakharah being the only one having, in addition, an entrance on the south side,) and in having the inclined passages leading to various apartments, which passages, to a considerable way down, have been filled up with solid blocks of stone, or granite of the exact size of the apertures.

The discovery of sarcophagi, mummies, and other memorials of the dead, show that the pyramids were used for tombs, and the filling in of the passages with solid blocks proves that the interior could not have been used for astronomical purposes, and the question of those passages having been constructed for the purpose of seeing the Polar Star, is set at rest by that circumstance; and Colonel Vyse, in his desire to further elucidate the question of the astronomical theory, communicated with Dr. Herschell, and has appended that distinguished astronomer's reply, which is to the following effect, viz:—"That 4,000 years ago, the present Polar Star, or Ursa Minoris, could, by no possibility, have been seen at any time in the twenty-four hours through the gallery in the great pyramid; but that the star *a* Draconis was, at that time, the Polar Star, and as it is comparatively insignificant, and only of the third magnitude, if so much, it can scarcely be supposed that it could have been seen in the day time, even in the climate of Ghizeh, or even in such a recess as the inclined entrance of the Great Pyramid, though it would have been directly in view of an observer stationed in the descending passage. No other astronomical relation can be drawn from the table containing the angles and dimensions of the passages, for although they all point within five degrees of the pole of the heavens, they differ too much and too irregularly to admit of any conclusions. The exterior angles of the buildings are remarkably uniform, but the angle of 52° is not connected with any astronomical fact, and was probably adopted for architectural reasons."

Col. Vyse's work also contains some valuable information in the form of notes by Mr. Birch, of the British Museum, upon the hieroglyphics discovered in the pyramids, with reference to the dates, prenomens, and royal standards of the monarchs by whom the pyramids were erected; but many of these hieroglyphics are quarry marks, some in red ochre, but instead of having been inscribed, like those on the pyramids at Ghizeh, upon stone brought from the Mokattam quarries, they were found also upon blocks quarried on the spot, and Mr. Birch observes,—"This is remarkable; in the former instance they may have been intended to distinguish the materials which had been prepared for a royal edifice, but in the present case their use is not obvious, and they can only have served to denote the founder of each particular pyramid." But Mr. Harris, an English merchant, who has been resident in Egypt above twenty years, in a letter to Mr. Perring, gives a more matter of fact meaning, by supposing that these inscriptions were directions to guide those who embarked the stones at the quarries, who conveyed it to its destination, and who built it when there, and that some of the characters indicate the building for which the stones were destined, and others the position in which they were to be placed, and that these directions could not be necessary to all the stones of a building, but would be requisite for all, or most, of those composing the linings of the chambers, passages, and other particular positions.

The desecration of these magnificent mausoleæ, by the intombment of subjects, as the inscriptions relate to the interments of a royal

scribe, and a military chief, is a surprising fact, which cannot now be satisfactorily accounted for; although history informs us that the memory of the monarchs who erected some of the pyramids was not held in much veneration.

As regards the period in which the pyramids were erected, Mr. Scoles could not offer any satisfactory opinion; by some authors they are placed more than 2000 B.C., or about 4000 years since; by others 1200 years later, or only 2300 since. This latter opinion is supported by Mr. Wathen, an architect, who, in his work on the arts, antiquities, and chronicles of ancient Egypt, from observations made in 1839, has very fully entered into this subject, and supposes the spoils, the gold and silver, taken from the Temple of Solomon, by the king Shishak of Scripture, 970 B.C., were applied to build these pyramids, and the author has given some curious dissertations on the chronology and dynasties of ancient Egypt. Many circumstances show that those at Ghizeh were the first erected, and that the pyramids of Dashhour were constructed in imitation of the stone ones, and to have been formed of bricks on account of the comparative cheapness.

The circumstance of many of these pyramids being carried up in degrees, or steps, agrees with a passage in Herodotus, relative to the mode of building the large pyramid, which he describes as follows:—"This pyramid," (the large one) he says, "was constructed in the manner of steps, by some called parapets, by others little altars; such being its original construction, they raised the remaining stones with machines made of short pieces of wood, from the ground to the first layer of steps, and when the stone was let down on this, it rested on a second machine standing on the first layer, from this it was drawn to a second layer, where another machine lay to receive it, for there were just as many machines as layers of stones, or, perhaps," continues Herodotus, "they transferred the same single portable machines to each layer on removing the stone, and thus the upper part of the pyramids was first finished off, then the next part, and last of all the lower ground part. Now these parapets, as they are termed, correspond with the side degrees, or platforms, as we would call them, seen in these pyramids, and on which the machines were placed; for the small steps formed by the sets-off of each course, as were seen in the large pyramid, previous to the insertion of the casing stones, would not have been wide enough for the machines to rest on."

The word parapet, as used in the translation, does not mean a protecting wall to a platform, as we, in general, understand it, but evidently the platform, and, in the north of England, it is so applied at the present time, and the foot pavement is called the parapet.

As connected with the pyramids, Col. Vyse has given an account of Capt. Caviglia's excavations in 1818, in front of the sphinx; when he discovered the steps, and a small temple in front of this gigantic figure, which is cut out of the solid rock. The paws stretch out 50 ft. in advance, and are built of masonry. That the monument is imposing in its aspect, cannot be doubted; but in its defaced state, it is difficult to perceive (to quote the words of the explorer,) the contemplative turn of the eye, the mild expression of the mouth, and the

beautiful disposition of the drapery at the angle of the forehead, which rivetted so much the attention of Capt. Caviglia.

Mr. Perring has annexed some remarks on the measure by which the pyramids were built, with reference to the cubit. The length of the ordinary cubit, as the name implies, was the distance from the elbow to the middle finger, containing six hands breadth, each of which was divided into four finger breadths. Mr. Perring says the dimensions of the pyramid agreed with a cubit as described in Ezekiel, chap. xl, v. 5, "In the man's hand a measuring reed, of six cubics long by the cubit, and a hand's breadth," and, therefore, contained seven hand's breadth, equal, in English feet, to 1.707 ft., and that by this measure a general agreement is obvious in the dimensions of the building.

The stone arched tomb near the great pyramid, named after Colonel Campbell, the Consul in Egypt, was next referred to; by some called the Nile girt tomb, being placed in a pit 30 ft. 6 ins. by 26 ft. 3 ins. wide, 53 ft. deep, surrounded by a trench, or narrow canal, 5 ft. 4 ins. wide, and 73 ft. deep. The bottom course of slabs, 5 ft. in length, was bedded on a layer of sand 2 ft. 6 ins. thick, (another instance of this mode of forming an artificial foundation,) and the side walls were formed with small stones. The ceiling of the chamber is formed of slanting stones, with a horizontal one, or stretcher, between, making the middle part of the ceiling flat, and the sides inclined. Immediately above this ceiling an arch commenced, which covered in the upper chamber; the intrados of this arch formed the segment of a circle which had a radius of 6 ft. 2 ins., and a span of 11 ft., was 3 ft. 10 ins. thick, composed of four separate courses, each well breaking joint. It had not been built upon a centering, observes Mr. P., (but how he ascertained this does not appear.) The stones were 4 ft. long, and 15 inches broad. Those of the first course had been cut to fit the joints, which radiated from the centre; with this course great care had been taken, but in the other rings the stones were rectangular, and packed up at the back with chips. Each course was separately grouted with fluid mortar. The masonry was beautifully worked, and the joints were scarcely perceptible in the interior. The undersoil of the stones of the inner course of the arch, have had the arrisses taken off, and were tooled round so as to resemble rusticated work.

There were indications that the central excavation, and the trench, also, was covered by an arch, and the whole was probably covered by a pyramid. From an inscription on this monument, the tomb was made for a scribe named Ohaikop, either during the reign of Psammetichus II, anterior to 604 B.C., or of Apries, posterior to 570 B.C. This tomb contained three sarcophagi: one of the granite, and a fragment of the basalt one is now in the British Museum.

This arch being, in the present day, one of ordinary construction, would not have required so full a description, if it were not about the oldest stone one we are acquainted with; it shows that the principle of the arch was well understood at the time, and that many arches

had been previously formed. The brick arches in the tombs at Thebes, are of much older date, according to Sir Gardner Wilkinson.

It was worthy of notice that the arch of Campbell's tomb had no abutments, and stood by itself, and its resemblance to the form of the sewers in the city of Westminster, must be apparent to every one conversant in that mode of building.

It was singular the Greeks, with these examples before them, did not construct arches (the curved form for ceilings being much used,) and that the introduction of the arch was not, with these exceptions, more general, at least, in Egypt; and Mr. Scoles expressed himself on this account skeptical on the subject of the antiquity of these arches. He was of opinion that the arrangements and dates of the dynasties by Egyptian antiquaries, was not so satisfactorily based as to make it clear to his mind that the period in which the kings lived, in whose reign these arches are said to be built, was free from the suspicion of error, and he concluded his paper by remarking, that the descriptions he had given of the pyramids, and other buildings, were entirely taken from Colonel Vyse's work, and that, in general, he had used the very words of the text. Civ. Eng. & Arct. Journ.

The Patent Wire Rope.

We have so often noticed in our columns the superiority of wire rope over hempen, for mines, railways, standing rigging, &c., that further remark would almost appear superfluous; but having lately had our attention particularly directed to an additional instance of its especial advantages for the latter purpose, we cannot avoid the opportunity of again noticing some of its peculiarly valuable features. It has now been in use about eight years, and many vessels, both in her majesty's navy, and the merchant service, have had their standing rigging constructed of this material for nearly that period, and, in every case, it has proved its superior durability, lightness, and economy, when compared with other descriptions of rope—requiring no change, or repairs, for ten, or twelve, years, which the patentee is ready to guarantee—being less than half the weight and size of hemp rope of the same strength, and 20 per cent. cheaper on first cost. Numerous testimonials from the owners and captains of vessels, both in the Royal navy, and mercantile marine, are convincing proofs of its indestructibility, after wearing for a period which would see out nearly three suits of hemp rigging. From among many others we subjoin the following testimonial of its superiority, from the owner of the schooner Marshall, (which vessel is now lying in the Thames,) as being one of the first vessels to which Mr. Andrew Smith's wire rope was applied, and which fully bears out the above facts:—

Sir,—I have much pleasure in stating, that my schooner has been entirely fitted with your patent wire rope, as standing rigging, for nearly eight years, and it now appears as good as when put over the mast-head; during that time the schooner has been constantly afloat, and trading in the Baltic and coastwise. T. Marshall.

Account of some Experiments on a Vessel called the "Liverpool Screw," fitted with Grantham's Engines, and Woodcroft's Screw Propeller. From the Minutes of the Proceedings of the Institution of Civil Engineers, Feb. 13, 20, and 27, 1844.

The *Liverpool Screw*, upon which the experiments, described in this paper, were tried, is a small iron vessel 65 ft. long by 12 ft. 6 ins. beam, and 3 ft. 9 ins. draught of water. She is propelled by two high pressure oscillating engines, with cylinders of 13 ins. diameter, and 18 ins. length of stroke. The steam, which varies from 56 lbs. to 60 lbs. pressure in the boiler, is admitted to the piston for one-fourth the length of the stroke, the remainder working by expansion. The nominal power was 20 horses, but the effective power rarely exceeded 18¼ horses. The cylinders are placed diagonally, at right angles to each other, and work to one crank upon the main driving shaft, which runs direct to the propeller without gearing, or bands. The propeller, which makes 95 revolutions per minute, is on Woodcroft's plan, with a pitch expanding from 10 to 11 ft.; after being enlarged at three several times, from 3 ft. 10 ins. diameter, it is now 5 ft. 4 ins. diameter by 20 ins. long; it is of wrought-iron, and consists of four short arms, whose united area is equal to 16 square feet; of this only about 13 ft. are immersed, a portion of the upper side being constantly above the water; the angle of the centre of the floats is 45°, and about 40° at the periphery. The author then gives the details of a number of experiments, and he states, that, although the proportions of the vessel were not favorable for speed, her length being only five times the beam, and the sectional displacement 28 feet, the speed was greater than that of all the steamers on the Mersey, except the large sea going steam vessels. That the "slip" of the propeller, when tried by Massey's log, was less than five per cent. That the action of the screw across the way of the vessel, did not appear to affect the steering, or have the slightest tendency to turn the head of the vessel.

The author is of opinion, that engineers, in general, fearing a loss might take place from lateral action, with a long pitch, and that the steering would be affected if the propeller was not immersed, have made the propellers too small, and that the short pitch, which had rendered a high velocity necessary, was detrimental. Several satisfactory experiments, in towing vessels, are also mentioned, and, it is stated, that in a heavy sea, the superiority of the screw propeller was very visible. The dimensions are then given for vessels of war and commerce, working with screw propellers, driven direct by oscillating engines, which, the author anticipates, would prove much more serviceable and sea worthy, than any of the paddle-wheel steamers now in use.

The paper is illustrated by a diagram of the propeller of the *Liverpool Screw*, and by plans of the machinery and general arrangements of the proposed frigate and steamers.

Remarks.—Mr. Rennie observed, that the Institution was much indebted to Mr. Grantham, for bringing forward the subject of screw

propellers; the more particularly as it had now become of national importance, and that every attempt at perfecting the sub-marine propeller merited encouragement. It was difficult correctly to assign the merit of the first invention of this species of propeller, as it had been tried at various periods, and with as varied results, on the Continent, in the United States of America, and in this country;* but it appeared certain that Mr. Samuel Brown, the inventor of the gas vacuum engine, was among the first who applied the sub-marine propeller with any practical effect. The propeller used by him was on the principle of a regular screw, and consisted of two blades, which were affixed at an angle of 45° to a horizontal shaft, which was placed in the bow of the vessel, and he believed that it had also been used in the stern. This propeller was driven by a gas vacuum engine, of the nominal power of 12 horses, and actually caused a vessel of 60 feet in length, to move at the rate of six, or seven, miles per hour. M. Sauvage, of Boulogne-sur-Mer, had also made several attempts at propelling vessels by the same means, and it was very gratifying to find that his services had recently been acknowledged and rewarded by the King of the French. It was, however, Mr. F. P. Smith, who first rendered the screw propeller practically useful; for his perseverance, being aided by spirited capitalists, induced the building of the *Archimedes* steamer, the machinery of which was constructed by Messrs. G. & J. Rennie, in the year 1839. The results obtained from that vessel were well known, and caused the subsequent construction of the *Princess Royal*, the *Great Northern*, H. M. S. V. the *Bee*, the *Rattler*, and the *Dwarf*, formerly the *Mermaid*, a model of which was exhibited, with the various forms of screws used in the different

Fig. 1. Fig. 2.

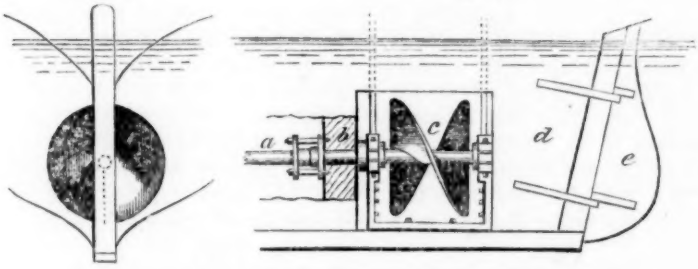


Fig. 2, *a*, Shaft; *b*, Stern-Post; *c*, Screw; *d*, Dead-Wood; *e*, Rudder.

* The dates of the experiments on screw propellers are nearly in the following order:—

Baron Seguier	1792	Cummerow,	1828
Fulton,	1796†	Sauvage,	1832
Shorter,	1802	Woodcroft,	1833
Trevithick,	1815	Ericson,	1836
Millington,	1816	Smith,	1836
Lowe,	1817	Lowe,	1838
Whytock,	1819	Hunt,	1839
Perkins,	1824	Rennie,	1839
Brown,	1825	Blaxland,	1840
Woodcroft,	1826	Carpenter,	1841

† In a letter to Dr. Cartwright, dated Paris, February 16, 1798, Fulton says, "I have just proved an experiment on moving boats, with a fly of four parts, similar to that of a smoke jack, and I find this to apply the power to great advantage, and it is extremely simple."

experiments. The *Great Britain*, not having yet been to sea, could only be mentioned as a projected experiment. Figures 1 and 2, are drawings of Mr. Smith's Double Threaded Screw, adopted in the "Archimedes."

The *Dwarf* was 130 feet in length, 16 feet 6 inches in breadth, 9 feet deep, and was 164 tons burthen. The power of the engines was 90 horses, making from 30 to 32 strokes per minute. Friction wheels without teeth were first tried for giving motion to the propeller; but on account of their slipping, and being very noisy, they were abandoned, and two spur morticed-wheels with wooden teeth, working into iron pinions, were substituted; the speed thus attained was from 150 to 160 revolutions per minute. The propeller was of cast iron, and was moulded in loam without a model, by means of iron templates cut to the required curve, which was formed from a solid cone revolving on its axis during the perpendicular descent of a tracer. The advantage of this form, over the cylindrical screw, was an increasing pitch, so formed, that while the propeller was rotating on its axis, the vessel was advancing, and thus producing the least possible amount of "slip." This was exemplified by the form of the various models on the table. The principal point to be obtained in a screw propeller, was a form which should offer but little obstruction to the water, and yet act upon it so as to exert full power in propulsion; a large portion of a complete screw having no useful effect, had induced the introduction of propellers with several blades; thus doing away with the useless part of the surface. A great portion of the centre part of the screw of the Archimedes had been cut away, but the effect had not been so good, on account of the arms of the screw obstructing the free passage of the water; the propellers with three arms, were, he believed, preferred to those with a larger number. The Dwarf's propeller consisted of three curved blades, formed on the conoidal principle, by variable curves, approximating to angles of from 27° to 30°, and advancing at the rate of 7 feet 6 inches per revolution. It was 5 feet 10 inches in diameter, by 2 feet deep in the direction of its axis, and the area was about 15 square feet, which was nearly one-fourth of the area of the midship section of the vessel at light draught; but since the Dwarf had been transferred to H. M. service, the mean draught had been increased one foot, and the area

Fig. 3.

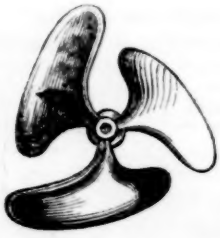
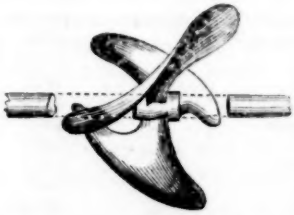


Fig. 4.



of the midship section in proportion; her speed had, in consequence, been reduced from 12 to 11 statute miles per hour. Figs. 3 and 4, are drawings of Mr. Rennie's Conoidal Screw Propeller.

The following were the results of the trials made by Captain Sir Edward Parry, Mr. Lloyd, and Mr. Murray, at the measured mile in Long Reach, on the 15th May, 1843:—

		Stat. Miles.	Mean.
1st experiment against tide,		9.890	12.145
2nd "	with tide,	14.400	
3rd "	against tide,	9.756	12.078
4th "	with tide,	14.400	
5th "	against tide,	9.890	12.203
6th "	with tide,	14.516	
General average,			12.142 Statute Miles per hour.

The draught of water was 5 feet 8 inches.

The Dwarf, under the command of Lieutenant Nicholls, left Greenhithe in company with the Hecate, Captain Bower, on the 14th of January, 1844, and reached Portsmouth on the following day; on the 20th she left Portsmouth, accompanied by the Hecate, and although it was necessary to reduce the speed of the engines to 26 revolutions, in order to keep with her consort during the night, they reached Falmouth on the 21st, after an additional run towards the Scilly Islands, making a distance of 200 miles in 23 hours, having burned 10 tons of coals in 27 hours, from the time of getting the steam up. The two steamers left Falmouth on the 23d, and reached Bear Haven on the following day, having run 135½ knots, or 156 miles, by the log, in rough weather in 12 hours, and with bad coals; the engines making from 28 to 29½ revolutions per minute. She anchored during the night at Bear Haven, and, on the following day, (the 26th,) reached Tarbert, the total distance from Falmouth being upwards of 400 miles.

Mr. Galloway said, that it was extremely difficult, if not impracticable, to arrive at the true amount of the "slip" of the propeller, because from its position abaft, or, in what is termed the dead-wood of the vessel, it acted in a current which was continually flowing to fill up the cavity, which would otherwise be formed by her progress through the water. The relative motion of a stream through the arches of a bridge, and in the wake of its piers, was an apt illustration of what unquestionably took place, (and from the same law,) in the case of a moving vessel. The screw, therefore, when acting in this current, might be compared to what would occur, if a paddle-wheel steamer was supposed to be moving in still water, while the floats acted in side canals, which flowed in the same direction as the vessel. Whether the benefits derived from this following current giving resistance to the screw, were not counteracted, by the deduction of so much of what is termed minus pressure from the ship itself, was not at present under consideration. His object was to show, that an accurate estimate of the amount of "slip" of a screw, could not be arrived at, until the rate of the following current, was first ascertained. That the "slip" must be much greater than Mr. Grantham assumed, would, he thought, be admitted, both from the circumstance he had stated, and from the fact that screw propellers, when worked with the

vessels at their moorings, invariably moved at a ratio at least equal to one-half the speed obtained when running. It was clear, therefore, that the "slip," which was dependent on the proportion of the resistance of the screw, compared to that of the vessel, must always exist in a degree; but that, it might in the screw, be reduced below that of the paddle-wheel, was evident, because in the best modifications of wheels, or where the immersed segment was small, the paddle must turn in the water, in effecting a change of position from its angle of entrance to that of its emersion, and this unavoidable angular action, even when the upper edge of the float coincided with the rolling circle, was still so much "slip" inevitably encountered; this "slip" too became very considerable when the vessel was in a sea-way; but the "slip" of the screw decreased with its magnitude, and, in the like proportion, its action approached that of a screw moving in a solid. It appeared, therefore, to him, that if the "slip" was small, the spiral, or increasing pitch, would be a disadvantage, because a true screw, would, under those circumstances, create little, or no, disturbance; while the spiral, in that case, would have the contrary effect, for the same reason that a helix would pass with facility through a solid, in which a spiral, or untrue, thread would become fixed, or would move with difficulty. In the absence of all "slip," or in so small a slip as Mr. Grantham assumed to have taken place in his experiments, the effect of a propeller with an expanding pitch, would be like that of a curved plate, moving through the water in a right line; while the true helix would have acted like a flat plate moving in the direction of its own plane; that is to say, the opposing forces would merely consist of edge resistance and surface friction, which are common to every kind of propeller. The advantage too, which was assumed to arise from this spiral propeller, merely affected the question of magnitude, for it was clear that, whether the screw acted upon a large body of water at once, or gave a second impulse to a lesser quantity, the result would be similar, as to the sum of the effect upon the vessel. It was true that in certain kinds of fish (he would instance the electrical eel,) the impulse produced by the ventral fin, was by an increasing spiral, the length of the curves becoming greater towards the tail; yet it appeared probable, as we could only see this eel in confinement, that the peculiarity he alluded to, was only developed in producing a change from rest to motion, for which it was well adapted, (because the "slip" was great, and the progress small,) and that when in rapid motion, it was probable, that the fin acted in a true spiral.

Mr. Rennie stated that the "slip" of the screw of the Dwarf, was from $\frac{1}{3}$th to $\frac{1}{2}$th. That with respect to the general question of the "slip," he conceived that it depended upon the comparative resistance between the vessel and the propeller. The case was similar to the immersed plane surfaces of the paddle-wheels of a steamer, and of the vessel itself; the resistance of the midship section was reduced by the forms given to the fore and after bodies, which gave the vessel what might be termed more "mobility." According to the experiments of Mr. Peter W. Barlow, read before the Royal Society, May 29th,

1834,* the "mobility" of several of her majesty's steamers was found to vary from $\frac{1}{13}$th, or $\frac{1}{24}$th, of a plane surface, equivalent to the area of the midship sections; or, in other words, a plane float of one foot square was equivalent to the midship section of the vessel, of which the mobilities were from $\frac{1}{15}$th to $\frac{1}{24}$th. There could be no doubt, that the improvements in the forms of the modern vessels, would have produced even less resistance, and he believed that it might now be taken at from $\frac{1}{30}$th to $\frac{1}{40}$th, so that, consequently, a less area of float, or propeller, would suffice to overcome the equilibrium, and produce less "slip."

Mr. Smith, of Deanston, observed, that the screw with three blades, which had been used in the Dwarf, seemed calculated to produce the best effect. The opening towards the centre of motion, by reducing the arms of the screw blades, as far as the requisite strength would allow, was judicious, as from the comparative slowness of the rotative motion towards the centre, little propulsive effect was produced; whereas the resistance to onward motion, by the arms, if they had not been reduced, might have been considerable; besides, if the arms were in the part broad, there would have been greater tendency to produce centrifugal action on the water. The gradual alteration of the angle of the blade, to the axis of the screw, or onward path, of the vessel, was also judicious, as it afforded a greater onward action of the blade at the entrance, whilst it gradually curved round to nearly a right angle with the path, so as to leave the water without causing any revulsion; it had thus an action, in some respects, similar to that of the tail of a fish. The salmon, when it "made a run," put down all its side fins, and solely, by the oblique action of the tail, was propelled forward with great force and speed, to which the flexibility and form of the tail, and, more especially, its curving form to accommodate its leaving the water without causing revulsion, principally contributed. Some years ago, Mr. Smith had made experiments with fans for blowing air, and so far as he could recollect, the form of greatest effect, much resembled, in principle, that of the propeller under consideration.

Mr. Farey said, that in order to continue the series given by Mr. Rennie, of steam vessels, which had been recently constructed with screw (or rather oblique acting,) propellers revolving under water, it would be desirable that the meeting should have the particulars of a vessel called the *Napoléon*, which had been built at Havre, by M. Norman, and fitted with engines and machinery constructed in this country by Mr. Barnes. Whilst at Havre, last summer, Mr. Farey had very minutely examined that vessel, and he considered it equal to any thing that had yet been executed of the kind, and a fair specimen of the perfection to which that mode of propelling, had, up to the present time, been brought for sea-going vessels. Mr. Barnes and M. Norman were well known in their respective departments, and they had been accustomed to co-operate during some years past. The engines which had been made and sent by Mr. Barnes to France,

* "An investigation of the Laws which govern the motion of Steam Vessels, deducted from Experiments, by Peter W. Barlow, C. E."—*Philos. Trans.* 1834, p. 309.

and fitted in vessels constructed by M. Norman, had, in most cases, paddle-wheels, with movable, or mechanical, paddles, on the plan introduced by M. Cavé, which possessed a decided advantage over ordinary paddle-wheels; the loss of power occasioned by the paddles entering and leaving the water too obliquely, being much diminished. In comparing the performance of the Napoleon, with vessels fitted with those mechanical paddles, there was less effect produced by the oblique acting submersed propeller, when considered merely as a mode of employing a given amount of power, to propel a given vessel through the water in a calm; but if the same power, as the engines of the Napoleon, had been applied with mechanical paddle-wheels at the sides of the vessel, (such as Mr. Barnes had been accustomed to construct,) the vessel would have had more speed in calm weather and smooth water, than had been attained by one revolving propeller, with oblique acting blades, applied under water at the stern; and it was possible that a greater amount of speed might have been attained, even with well proportioned common paddle wheels. Nevertheless, the submerged propeller, at the stern, admitted of the use of sails, in concert with steam power, or in lieu of it, (when the wind was strong, and in a tolerably favorable direction,) with much greater advantage than could be done in steam vessels, with the ordinary, or even mechanical, paddle-wheels, although the latter were well adapted for acting in concert with sails, because they would perform well, when the paddles were either deeply, or slightly, immersed. The proper and most advantageous action of ordinary paddle-wheels was very greatly impaired, by variations of immersion; the mechanical paddles, when properly proportioned, were less influenced, and the submerged propeller still less; in fact, being wholly under water, at all times, its action did not appear to be sensibly affected by any such alterations of the depth of its immersion, as were likely to take place in the roughest waves, or the greatest variations of draught. When all circumstances were considered, it might be safely concluded, that vessels fitted with revolving submerged propellers, would answer well for making regular sea voyages, either in winter, or summer; and, on an average, he thought, that their passage would be performed at least as well, if not better, than those of any steam vessels now in use, and with an economy of fuel, arising from such vessels making a more advantageous use of their sails, and less use of their engine power.

M. Norman, in reply to questions from Mr. Rennie, regretted that his slight knowledge of the English language, not only precluded him from fully comprehending the narrative of the paper, and the statements of the several speakers, but also rendered it obligatory that he should communicate to the meeting in French, the few remarks which he could not withhold, after the pressing notice of the chairman. Many experiments had been made in France, with screw propellers, by numerous inventors, as far back as the latter part of the eighteenth century, and by M. Cavé, and others, at recent periods, but the most extensive experiment was that of the Napoleon, for which Mr. Barnes had constructed the steam engines and machinery in England, and

which, he might be allowed to say, had given complete satisfaction. The Napoleon was built at Havre, and launched at the latter end of 1842, for the service of the French Government Post Office in the Mediterranean. The vessel was built of oak timber, copper fastened and coppered. Its dimensions were as under:—

	Metres.		English. Ft.	Ins.
Length of vessel from stem to stern,	47.5	=	155	8
" at the surface of the water,	45.2	=	148	6
Extreme breadth,	8.5	=	27	8
" " at the surface of the water,	8.32	=	27	4
Draught of water when light loaded, abaft,	3.6	=	11	10
" " " " forward,	2.26	=	7	5
	Sq. Mrs.		Sq. Ft.	
Area of the midship section, at the above draught of water,	13.4	=	144	
Area of the surface in contact with the water, occasioning friction,	401	=	4320	

The revolving propeller was fixed in a space, or opening, abaft the usual stern-post, (to which, in an ordinary vessel, the rudder would be hung,) and withinside another stern post, which was erected on a prolongation of the keel farther abaft, for sustaining the rudder, so as to leave a space between the two posts, for the reception of the propeller. The centre of the propeller was (1.82 metre =) 6 feet beneath the surface of the waters; its diameter was (2.28 metres =) 7 feet 6 inches, and the highest point of its periphery was 2 feet 3 inches below the water line, when the mean draught of water aft was about 11.82 feet. Four propellers of the same diameter, but of different forms, were made, in cast iron, under the direction of Mr. Barnes, and were tried with various success during the past year. The propellers had been altered several times, and it was found that within certain limits, by cutting away the ends, so as to shorten the length of the screw, (which had also the effect of diminishing the surfaces of the blades,) the speed of the vessel was increased, and the vibration was reduced; a portion of this effect had, however, been attributed to using four arms. A propeller with three blades, occupying the whole of the circle, was first tried; others which presented less central surface answered better, and the best, which was still in use, had four blades, which occupied $\frac{6}{10}$ths of the area of the circle, when viewed in the direction of the axis, leaving $\frac{4}{10}$ths of that area vacant, for the free escape of the water between the blades, whose obliquity was such as to produce an advance of (3.12 metres =) 10 feet 3 inches in a revolution. The steam engines were nominally of the power of 65 horses each, = 130 horses together; their cylinders were 45 inches in diameter, their pistons making usually from 27 to 28 double strokes of 3 feet 6 inches in length per minute. The motion was communicated to the propeller by a spur wheel of 126 teeth, working into a pinion of 29 teeth, which gave nearly $4\frac{1}{3}$ revolutions for each stroke of the engine, or about 120 revolutions of the propeller per minute. The ordinary speed of the vessel, without any sails being used, was

10 knots, or 11½ statute miles, per hour. She had three masts of considerable height, the rigging being that of a brig, forward, and that of a schooner at the main and mizen masts, with as great an extent of canvas as would be used in any sailing yacht. When the wind was favorable, and the sails could be used, the speed increased to 11 or 12 knots per hour. After a series of experimental voyages, the vessel had gone to her station in the Mediterranean, where she was now in constant service, and had gone through some rough weather with great success; her motion was described as being remarkably easy, she rolled very little, steered better than ordinary vessels, for the propeller appeared to give increased effect to the rudder, and the propeller had never been observed to show itself above the water, even in the heaviest seas, when the pitching was at its maximum. Figures 5 and 6, are drawings of the Napoleon Screw Propeller.

Fig. 5.

Fig. 6.

Mr. Galloway remarked, that the properties of a screw with an increasing pitch, had been slightly investigated by Tredgold, in his work on the Steam Engine, p. 310, so early as 1827. The author had briefly referred to the subject of screw propellers, and had given some logarithmic calculations of their properties, from which he drew the conclusion, that the true screw could not be carried beyond a single convolution, with any good effect; whereas, by a progressive increase of the pitch, the propelling effort would be continued, until the spiral became expanded into a straight blade parallel to the axis. It was Mr. Galloway's opinion, that more was to be expected from ascertaining the best position for placing the screw, with reference to convenience and effect, than from any slight change in the form, or the number of the blades, or propellers.

Mr. Samuda said it appeared to him, that the action of the propeller tended to drive the water from it at a right angle with its surface, and as it formed a diagonal line with the keel of the vessel, some portion of the force was not efficiently used for propulsion; he conceived, therefore, that by a judicious arrangement of shrouding round the extreme circumference of the propeller, the diagonal currents of the water, might be diverted into a direction parallel with the way of the vessel, and thus cause the whole of the re-action to become available for propelling. Such an arrangement would enable propellers of a much coarser pitch to be employed, and their speed being reduced in proportion, they could be more readily driven directly by the engines, without the intervention of bands, or gearing.

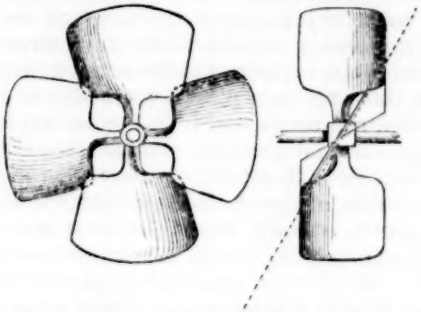
M. Norman said, that M. Cavé had tried a series of experiments on screws of various forms working in cylinders; and also, he believed, with shrouding on their extremities, and he understood that no advantage had been found to result from such modifications.

Mr. Cowper presented an instrument, which he had exhibited when the aerial machine was incidentally mentioned; it consisted of a fan composed of three, or more, blades, set at a regular curve upon an axis. When this axis was placed vertically in a socket, and a rapid rotary action communicated to it, the fan rose in the air to the height of between 100 and 150 feet. On reversing this fan, and using the same propelling force, it would not rise at all. This fact evidently showed that the action of the curved fan upon the air, or of the propeller upon the water, was like that of a screw in a solid, every part of the surface of the blade of a well formed propeller producing its portion of effect. Mr. Cowper directed attention to the contrary effect produced by two fans of similar areas, whose arms were, in the one case, mere planes set at an angle with the axis, and in the other, blades forming part of, and being placed at a given curve around the axis. If it were supposed, that the surface of each blade was divided into a given number of equal parts, when the fan, of the former, or angular, shape, was set in motion, the first part impinging on the air, communicated a movement to it, and the second and succeeding parts, finding no resistance from the disturbed fluid, the body had no tendency to rise; but in the latter, or curved shape, the second and succeeding parts, tended to overtake, and act upon an undisturbed fluid, and thus had a tendency to rise upon an irregular inclined plane, described by its gyration through the air. By the law, that the resistance increased as the square of the velocity, he conceived, that in adapting propellers to vessels, their dimensions should be proportioned, not only to the area of the midship section, but also to the speed of the engine. At the same time, the consideration of the form of the blades was very important. In experiments with the revolving fan instrument, he found, that although, on all occasions, the same rotative force was applied, a fan with three arms, whose united areas were 3.721 inches, when set at a given angle, did not rise freely; the same form and area, when set to a proper curve, rose to a very considerable height; but when a fan of twelve arms, formed from a circle, or disk, of 28.274 inches area, divided into twelve arms, was set in motion, it would not rise at all. With other fans, of intermediate forms, areas, and curves, various results were obtained, which were curious problems for engineers interested in the construction of propellers.

Mr. Grantham expressed his pleasure at finding his paper had so much excited the atention of the meeting, and he hoped it would be followed by communications from members who had devoted more time to the subject; for instance, the numerous experiments made by Mr. Brunel and Mr. Guppy, before deciding on the use of the screw propeller for the Great Britain, and those made in the presence of the Government Engineers, Mr. Lloyd and Mr. Murray, on board the Bee, the Rattler, &c., would be very interesting. Mr. Grantham exhibited a diagram of the propeller used on board the Liverpool Screw,

figures 7 and 8, composed of four blades with broad shovel ends, fixed at a mean angle of 45°. This form, although very successful in this

Fig. 7. Fig. 8.



case, could not, he thought, be recommended for large diameters. The results of his observations induced him to think, that the blades of a propeller should not be more than four feet apart; he would, therefore, advise the adoption of Ericson's form and mode of construction, which he considered the best that had hitherto been introduced: the ring within the arms permitted any number of blades to be affixed, and a large area of acting surface, judiciously disposed, could thus be obtained. He objected to propellers with three arms, chiefly on account of the small amount of surface obtained. As to the "slip," which Mr. Galloway had so ably commented upon, he was aware that it did exist in all cases, but he was of opinion that the amount was exaggerated; he had not only made accurate experiments with Massey's log, but being repeatedly in a small boat, which was towed close astern of the Liverpool Screw, he found that there was very slight disturbance of the water, and that there was not any depression behind the blade of the propeller on entering the water; this could be easily observed, as a portion of the upper blade was always above the surface. It had been anticipated that this arrangement would, with so short a vessel as the Liverpool Screw, have caused a constant tendency to bear over in one direction, but not the slightest disturbance of the steering was perceived, and the vessel's course seemed to be quite as straight as it would have been with paddle-wheels. Mr. Grantham wished it to be understood, that his object in bringing forward the account of the Liverpool Screw, was not so much to cite that vessel's powers, as to point out the feasibility of working propellers at a slower speed, and that condensing engines could be applied with advantage, avoiding the bands and gearing, which had hitherto been found so objectionable.

Mr. Braithwaite was of opinion that where deep immersion was not practicable, two propellers would be preferable, in order to prevent any disturbance in the steering. Captain Ericson had adopted that plan in boats of light draught. Mr. Braithwaite then presented a drawing of the midship section of the Princeton American frigate, showing the elevation of Ericson's engine on board. The vessel was

164 feet long, with a breadth of beam of 30 feet; the depth of the hold was 22 feet 6 inches, the draught of water was 17 feet 6 inches, and the burthen about 700 tons; the propeller was 14 feet in diameter, with six blades, and made from 32 to 36 revolutions per minute, at which rate the vessel's speed was stated to be nearly 14 miles per hour. The engines were about 400 horses power; they were of peculiar construction, having two steam cylinders, or chests, containing vibrating pistons, or flaps, with cranks upon the ends of the suspending pivots; both these were coupled by connecting rods to a main crank on the driving shaft; the length of these cranks being so proportioned, that their alternate vibrations should give a rotary motion to the main crank, and thus act directly upon the propeller, without the intervention of bands, or gearing.* This principle was tried successfully in the year 1839, by Ericson, on the Thames, in a tug boat named the Robert F. Stockton,† after the projector, who had succeeded in introducing the system to the American navy, and now commanded the Princeton. The boilers of the Princeton were constructed for burning anthracite; the whole of the machinery was so placed as to be out of the reach of shot, and the vessel was ship-rigged, so that by unshipping the screw, she could be rendered as effective as any sailing vessel, with a fair wind, or in case of accident to her machinery. Mr. Braithwaite hoped in a short time to bring before the Institution, an account from Captain Ericson, not only of the Princeton, but of several of the other vessels he had fitted with his engines and propellers, since his residence in the United States. Figs. 9 and 10, are drawings of Ericson's Screw Propeller.

Fig. 9.

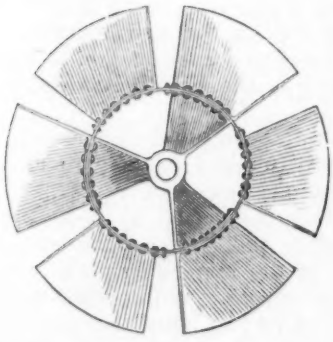


Fig. 10.

Mr. Galloway said, that during the experiments with the Archimedes, a proof had been elicited, that the "following current" had a very considerable effect on the action of the propeller. During one of the trials the vessel was backed astern, when it was found that the speed of the engine increased three, or four, revolutions per minute, while the speed of the vessel appeared to have diminished. This

* Vide Mech. Mag., vol. xxxii, January, 1840, p. 290.

† Vide Mech. Mag., vol. xxx, January, 1839, p. 281.

experiment was, he contended, conclusive as to the fact, that the "slip" was greater than would appear by looking merely at the rate of the vessel compared to that of the screw. He did not, however, think that the "slip" ought to be considerable, with a well constructed propeller. Increased magnitude in a screw would have the same effect in creating resistance, as increased magnitude in any other submerged body. The utility of the increasing pitch, however, was involved in, and solely depended on, the amount of "slip" which would be found to be attended with the least disadvantageous results in other respects; and here Mr. Galloway would observe, that Mr. Cowper's experiments, with the revolving fan instrument, confirmed his view; for it must be recollected, that there the "slip" was much greater than the rate of ascent; the only condition being thus developed in which the utility of an increasing pitch could be contended for. The advantage of turning the propeller by the direct action of the engines, was generally acknowledged. The method of driving it was nearly the only problem remaining for solution, and that difficulty being once overcome, screw propellers must necessarily, from their vast advantage over paddle-wheels, in every respect but that, be universally adopted.

Mr. Hawkins said, that about the year 1825, Mr. Jacob Perkins adapted to the stern of a canal boat, a propeller of about 25 feet in circumference, which might be described as resembling two sets of wind-mill vanes, the solid axle of one set revolving within the hollow axle of the other, the two axles being turned in contrary directions, and the dip of the blades being about half their radius. The propulsive force was stated to have been very effective; the experiments, which were put an end to by the breaking of part of the engine, were never renewed, in consequence of disputes among the patentees; but he considered that propeller as the best that had hitherto come under his notice, and he had endeavored to draw attention to it by reading an account of it, at the meeting of the British Association at Cork, in 1843.

Mr. Grantham stated, that in order to test the comparative effect of the expanding pitch, Mr. Woodcroft had adapted to the stern of a vessel, two screws of equal area, one being of a regular, and the other of an expanding pitch; they were connected by a cross shaft, and were worked by manual power, and it was found that the vessel always yielded to the impulse of the expanding pitch propeller, and was turned by it from the direct course. With respect to the advantage of a large amount of surface, he had found that the action of the propeller of the Liverpool Screw, which had been enlarged three times, was decidedly improved by the alterations; the speed of the engines always remaining the same.

Mr. Galloway said, that the surface of the propeller of the Liverpool Screw, might probably have been too small at first, and, therefore, each increase would naturally improve its effective power. The area of the propeller should be in proportion to the body to be moved; this law was common to screw propellers, and to paddle-wheels.

The President expressed the gratification he felt at the useful discussion, which had been raised on so interesting and novel a subject as the screw propeller, which had become one of such importance in steam navigation, that the government had directed the serious attention of their officers to it; and he trusted that the examination of this question, like that of the action of Cornish engines, at the meetings of the Institution, would materially tend to its elucidation. As soon as any new and really useful invention was matured, and brought sufficiently into use to enable its merits to be calmly discussed, it was one of the main objects of the meetings, to examine it, and he hoped that in a short time a detailed account of the Atmospheric Railway would be submitted by Mr. Samuda, for the consideration of the Institution.

Oxidation of Iron.—Mr. Perkins stated, that on a recent examination of the Napoleon, at Marseilles, the cast-iron of which the propeller was composed, was found to have undergone considerable change, and to have become so soft that it could be cut with a knife.

Mr. Grantham believed, that circumstance was owing to the cast-iron propeller working too near the copper sheathing of the vessel. Iron vessels would not be liable to that objection. The amount of oxidation was apparently increased by the cast-iron remaining in a state of rest; now, as screw propellers were usually in rapid rotation, and were also generally so constructed that they could be unshipped, they could be painted and preserved from any injurious amount of external corrosion, although a chemical change might still be induced when the cast-iron was in contact with copper.

General Pasley had observed, in the metal raised from the wrecks of the Edgar, and the Royal George,* that the cast-iron was generally soft, and, in many instances, resembled plumbago; that when small pieces were cut from any of the iron guns, or that these pieces were pounded in a mortar, heat was evolved, but after two, or three, days the metal cooled again! some of the shot which had been found had burst into several pieces, under this heating action.† The wrought-iron was not so much injured, except when it was in contact with copper, or gun metal; some of it appeared to have undergone an unequal action, and presented a reticulated surface, as if the softer portions had been destroyed, leaving the harder fibres uninjured.‡ Those portions of the wrought-iron which were used by the smiths in the dockyards, were declared to be of a better quality than any modern iron. Neither the copper, nor the gun metal, were much acted upon, unless they were in contact with iron.

Mr. Cottam had observed, with great attention, the iron guns which were brought from the Royal George to the Tower; when they arrived they were soft, and could be easily cut with a knife;‖ but when

* The "Edgar" was sunk in 1711, and the "Royal George" in 1782.

† A similar action was observed in the cast-iron shot raised from the "Mary Rose," which was wrecked in the reign of Henry VIII.

‡ This appearance was also noticed by Mr. Mallet, and is mentioned in his paper, "On the Corrosion of Iron, &c."—See *Journal*, vol. vi, p. 386.

‖ Vide Trans. Inst. C. E., vol. i, p. 204.

he examined them some time afterwards, the metal had resumed its original hardness. This was frequently the case with pump trees, which had become soft, from immersion in mineral water, but on being taken out and laid aside for a time, they became hard again.

Mr. Galloway stated, that this spontaneous development of heat by cast-iron, which had been long immersed in salt water, had been frequently observed. A striking instance of this kind occurred at Woolwich, when an attempt was made to preserve the copper sheathing of vessels from corrosion. Sir Humphrey Davy suggested to the Admiralty, that the decomposition of the copper sheathing could be neutralized by the application of tin, zinc, or any other easily oxidable metal; the plan was tried on several vessels, by attaching to them zinc plates, and the protection was so perfect, that the ships' bottoms became covered with barnacles and weeds. Cast-iron was then substituted, on the supposition that the partial oxidation, which would be permitted by the iron, would prevent the fouling of the copper, but that the ordinary rapid destruction would be modified.* The Magicienne frigate, having been at sea for some time, with cast-iron protectors, was docked at Woolwich for examination, when it was found that the protection instead of being partial, had been local, for while the greater portion of the surface of the copper was oxidized, as usual, the parts contiguous to the iron had been perfectly protected, and were covered with barnacles. Mr. Marsh (of the Ordnance Department) broke off some small pieces of the iron, which presented the appearance of plumbago, was easily cut, was greasy to the touch, and left black marks on the paper;† in a few minutes the heat became so great as to ignite the paper in which the pieces were enveloped. The development of heat was generally supposed to

* Vide Mr. Wilkinson's paper "On the Sheathing of Ships," see Journal, vol. v. p. 169.

† In Dr. Thomson's "Annals of Philosophy," are the following remarks:—"Dr. Henry states, that 'cast-iron having been in contact with muriate of lime, or muriate of magnesia, most of the iron was removed. The specific gravity was reduced to 2.155, and what remained was chiefly plumbago, and the usual impurities.'

"Dr. Brande found that 'a cast-iron gun had undergone a like change, from being long immersed in sea water. To the depth of an inch it was converted into a substance, having all the external character of plumbago. The component parts were—

Oxide of iron, ...	81
Plumbago, ...	16
	97

"Mr. Mushet, in his work on 'Iron and Steel,' states, that wrought-iron sometimes, though very rarely, undergoes the same change.

"Professor Daniel, in the 'Quarterly Journal of Science,' vol. ii, p. 290, says, 'I am inclined, under all the circumstances, to believe that the triple carburet, as it is at first obtained, consists of iron and silicum in the metalline state, united to carbon. When brought into contact with oxygen gas, the metals become converted to protoxides, giving out heat without separating from the carbon.'

"By analysis, he found the substance to consist of

Red oxide of iron, 7.0 =	6.2 black oxide.
	4.9 silex.
	11.2 carbon.

"The same author states an important fact, bearing on the present question, namely, 'that it took three times as long to saturate an acid, when it acted on white cast-iron, as when it acted on the grey kind.'"

proceed from the rapid absorption of oxygen by the mass, on being brought into the air, from the water, where it had already received a certain amount of oxygen. The production of heat being, in this case, governed by the same law as that under which animal heat, and the heat of combustion, were developed.

Mr. Homersham said, that the water of the Thames, up as high as Richmond, had the same effect as sea water, in rendering cast-iron soft.

Mr. Simpson believed, that if hard grey cast-iron, with a good surface, was used for castings, which were subjected to the action of sea water, but little injurious effect was to be dreaded; he was so convinced of the fact, that he was about to use cast-iron extensively for piles. He had recently examined some cast-iron piles, which had been in sea water for sixteen years, without any detrimental effect being produced.

Mr. Jordan thought, that it was very desirable to mark the difference between the composition of brass, and the alloy of copper and tin, used in casting guns. With brass, in which zinc formed a part of the composition, it was probable that the iron would have been acted upon with less energy, because it was more electro-negative than zinc; but the gun metal acted positively upon the iron, and, apparently, altered the substance.

Mr. Braithwaite said, that the proportions of the mixture, used for the bearings of machinery, were usually 92 per cent. of copper, and 8 per cent. of tin.

The President said, that although the discussion had taken a direction which had not been anticipated, and was foreign to the original subject, he had not attempted to lead it back again, because the question of the causes of the chemical change in cast-iron, in certain positions, and the means of preventing it, was of the utmost importance to engineers, particularly as in all modern works so much cast iron was used.

Civ. Eng. & Arch. Journ.

Proceedings of the Institution of Civil Engineers.—From the London Athenæum.

Breaking of Railway Axles—April 23.—The first paper read was by Mr. C. Geach, who had promised, at a meeting of the Institution, in February, 1843, to give the results of more extended comparative trials of the strength of solid and hollow axles. The result of the present experiments was as decidedly in favor of the solid axle, as the former ones had been in favor of the hollow axle, so that, as far as the practical utility of the examination extended, the results were useless.

A paper was read by Mr. Glynn, relative to the fracture of railway axles, which he attributed to the constant succession of blows received by the axles in travelling. The action was stated to be similar to that of an axle laid on the edge of an anvil, and subjected to a series

of smart blows of a hammer, while in constant rotation. The fracture presented the appearance of a clean annular cleft all round, for the depth of half an inch into the body, the centre part being crystalized, and reduced so much as to be unable to bear the weight and the torsion to which the axle was subjected, by the pressure of the break on one of its ends. These observations had induced the railway company to apply the power of the break upon both wheels simultaneously, thus avoiding the torsional strain.

An account of the Scaffolding used in erecting the Nelson Column, Trafalgar Square, by Mr. T. Grissell, was read. This scaffolding, which was first used in London, for the erection of the facade of the London and Birmingham Railway station, by Messrs. Cubitt, then by Messrs. Grissell & Peto, at the Reform Club House, and also at Woolwich, in forming the new graving dock, was composed of sills, uprights, cross-heads, longitudinal timbers, braces, and struts, all of whole timber. The upright timbers were slightly tenoned into the horizontal timbers, and the junctions secured by iron dogs, driven into the timbers diagonally across the joints, which were preferable to bolts, or spikes, as they could be more easily withdrawn, and the timber was not injured. It was stated, that with this scaffolding, and the traveling machine at its summit, one mason could set as much work in one day as was formerly done in three days by the old system, even with the aid of six laborers, who are now dispensed with. The base of the scaffold was 96 feet square, exclusive of the raking braces; the height of each stage varied from 21 feet to 48 feet; the total quantity of timber used in its erection was 7,700 cubic feet, and its cost was 240*l.* for labor in erecting.

Preserving Timber.—It was recommended that the plan adopted at Liverpool, of bonding timber upon dry land, instead of allowing it to float in timber ponds, should be made use of in London, as, by that means, the timber would be better seasoned, would be less subject to decay, and the Kyanizing process would not be so much required.

Scaffolding employed for the construction and repair of Columns, Obelisks, &c.—A paper, by M. Pierre Journet, described the scaffolding employed by him for the construction and repair of columns, obelisks, and chimneys, of great height, at Paris; and also the machine used for raising building materials, at the Houses of Parliament, the mansions at Albert Gate, Hyde Park, &c. The scaffolding consisted of a simple combination of a number of brackets, fixed at regular distances of about five feet apart vertically, upon girdles of chains and screws, braced tight round the column under repair: upon these brackets the platforms were laid, and, as the workmen proceeded upwards, the lower brackets were alternately raised to the platforms above, where the workmen stood. The progress thus made in forming, and in taking down, a scaffold, was stated to be very rapid, with corresponding economy of time and expense; no poles, or cords, were used, and no waste of material occurred. By these means the obelisk

of Luxor, at Paris, was repaired in a very short time, and at a very small cost. The machine for raising building materials consisted of an endless chain of square open links, the lower end revolving around a driven wheel, and the upper end around a corresponding wheel, fixed upon a scaffold, at the height of the building. The hods, buckets, and baskets were each furnished with a hook, by which they were suspended on the rising side of the chain, and when they arrived at the necessary height, they were taken off by laborers, and carried to the spot where the materials were to be used; when empty they were hung upon the descending side of the chain, and lowered to be again filled. Messrs. Grissell & Peto, who had used these machines, expressed themselves much pleased at the economy they effected, which would induce them to employ them more extensively with engine power, for the erection of the Victoria Tower, at the new Houses of Parliament.

Description of the method employed for repairing a Chimney 120 feet high, at Messrs. Cowper's Cotton Mills, Glasgow, by J. Colthurst, was read—April 30.—The means adopted were thus described: the workman was provided with a broad leather belt, to which was attached a strong spring hook; staple shaped ladder irons, with flat jagged ends, were driven into the joints above each other at intervals of 15 inches apart, by the man standing on them in succession as he ascended, until he reached the top; his safety was secured by fixing the spring hook on the ladder iron immediately opposite his waist, which enabled him to use both his hands when working; a rope was also passed around his waist, and down inside the ladder irons, to support him in case one of the ladder irons broke, or came out; he thus succeeded in removing some ornamental plates of iron which had been loosened by a storm. In descending, the workman took the ladder irons out one after the other, the whole operation being performed in two days and a half; the total cost, including a bonus of 5*l.* to the workman, was only 13*l.*

The first part of a paper by Mr. W. Fairbairn, on the Reduction of the Magnetic Ores of Samakoff, (Turkey) was read. It commenced with reviewing the few attempts which had been made towards improving the methods of treating the richer iron ores of England and of foreign countries; the great English iron makers having restricted themselves to using the lean carbonates of iron, on account of the facilities they offered for working; the great advantages which might have resulted, both in the quantity and quality of the metal, produced from rich ore, have been thus neglected. It is stated that Mr. Ohanes Dadian, an active and enterprising Armenian in the service of the Sublime Porte, brought to this country specimens of magnetic iron ore, and of bituminous coal found in the district of Shamakoff, in Turkey; he had them analyzed at Paris and in England, and found that the ore was nearly a pure oxide of iron, containing about 63 per cent. of metal, that it was free from sulphur, arsenic, and other deleterious matters, and that there was mixed with it about 12 per cent. of siliceous earth. The ore was described as being found in the

form of a fine sand, covering extensive plains, where it had been deposited to the depth of several feet, probably by the action of water on the mountains around, where a similar ore existed in considerable masses. In consequence of the favorable report of the assayists, and acting on the advice of Mr. Fairbairn, Mr. Ohanes Dadian determined to persevere in his projects, and his attention being directed to the process invented by Mr. Clay, for producing malleable iron direct from the ore, as described in a paper read at the Institution of Civil Engineers, February 14th, 1843, he secured that gentleman's services to conduct some experiments, and subsequently engaged him to proceed to Turkey to prosecute the working of the iron ore on an extensive scale. Mr. Clay's report, and that of Mr. Hague, were fully given; they contained details of the various ingenious modes employed to work the ore, which, being in the state of fine sand, either fell unmelted through the fuel into the bottom of the furnace, or was blown out of the top by the force of the blast. At length Mr. Clay, thinking that if the ore could be deoxidized by a previous operation, it would be in a fitter state for fusion in the blast furnace, submitted it to a partial process, as far as causing it to form into lumps; in that form it was easily fused, and produced cast-iron of a peculiarly ductile fluid, and yet strong character, of which specimens were exhibited; the success of this plan was considered so complete, that the preparations were immediately commenced for erecting works in Turkey on a large scale.

The second part of Mr. Fairbairn's paper was read—May 7.—It noticed the remarkable richness and purity of the iron ores of the East, and the superior quality of the Damascus steel, produced from iron made, apparently, in the most primitive manner; it was remarkable, that, up to the present time, there had been but little change in the manner of manufacturing charcoal iron, even in England; this might be accounted for by the small quantity of wood charcoal used for smelting iron; but it appeared that, with the exception of that which was sent into Staffordshire and South Wales, for mingling with the lean ores of the coal measures, but little of the hæmatite, or rich ores of Lancashire, Cumberland, Cornwall, or Devonshire, was used, although in richness and in quality of metal they equalled those of foreign countries. The paper then entered upon the experiments on the transverse strength of the Turkish iron, and also of the iron from other rich ores, presenting the results in a tabular form, mingled with those which had been reported on previous occasions, in the Transactions of the Philosophical Society of Manchester, and in the Reports of the British Association. These tables were arranged so as to afford the means of comparison of the strength and other qualities of various irons, and also for practical purposes, to furnish a guide for selecting such irons as, by proper mixture of the various kinds, would enable unerring results to be arrived at by the founder, when engaged in producing castings for the engineer, the architect, or for various purposes in the arts, or in construction. Simple rules were also given for finding the breaking weight of beams cast from the fifty-two kinds of iron, which had been experimented upon.

Prismatic Colors in Homogeneous Bodies.—A letter was read from Dr. Schafhæutl, drawing attention to some experiments made by Sir David Brewster, on the prismatic colors generated in homogeneous bodies, when pressure was applied to them; these experiments were recorded in the Philosophical Transactions for 1816. They furnished a method of rendering visible, and of measuring the mechanical changes which took place during the compression, dilatation, or bending of transparent bodies. He also stated that the tints produced by polarized light, were correct measures of the compressing and dilating forces, and by employing transparent gums of different elasticities, the change, which occurred in bodies before they were either broken, or crushed, could be ascertained, and that forming models of arches of simple refracting substances, such as gum copal, &c., giving different degrees of roughness to the touching surfaces of the voussoirs, and exposing the model to polarized light, the results of any degree of friction on the joints would be readily observed. It was stated that similar experiments had been tried by M. Bist, at Paris, almost simultaneously with Dr. Brewster, and that, without doubt, this had materially assisted Dr. Robison in his valuable treatise on the strength of materials.

A description of the Iron Dock-Gates at Montrose Harbor, by James Leslie, was then read.—These gates were described in great detail, giving all the dimensions of the several parts, which were fully shown by drawings. The framing was of cast-iron, covered on both sides with wrought-iron plates $\frac{3}{8}$th in. and $\frac{5}{16}$th in. thick, riveted on, so as to be water tight, and to render the gates buoyant, and partly to compensate for the weight of metal in them, which was about 87 tons. The gates were 55 feet wide, and 22 feet 6 inches deep, and were entirely composed of iron, except the bottom bars, and the false mitres, which were of oak. The sluice valves were of iron, without any brass on the faces, but the backs were covered with zinc plates, and the bolts had zinc nuts screwed over the iron ones, in order to check the oxidation of the iron, by the galvanic action of the two metals. A general account of Montrose Harbor was given, and it appeared that although there had existed some doubt as to the successful formation of a harbor in such bad ground, being entirely sand and gravel, which stood full of water within a few feet of the surface, the work having been submitted to Mr. Walker, president of the Institution, and having his approval, had been satisfactorily executed, and stood well.

Atmospheric Railway—May 14.—The paper read was an account, by Mr. J. Samuda, of the atmospheric railway; it commenced with the general principles of the system, describing it as a system of working railways, in which the moving power is communicated by means of a continuous pipe, or main, laid between the rails, and divided by valves into suitable lengths for exhaustion; a partial vacuum is formed in the pipe, by air-pumps, worked by machinery, at intervals, along the line. Along the upper side of the main is a continuous aperture, which is covered by a leather valve guarded above and

below with iron plates, hinged on one side to the pipe, and falling into a groove, containing a mixture of wax and tallow on the opposite side, so as to close the aperture. A piston is attached at some distance in front of, and beneath, the leading carriage of the train, and, by means of a packing of leather, fits within the main pipe, so as to be nearly air-tight. When a vacuum is formed in the main, in front of the pistons, and in the direction in which the train is to travel, the air impinging on the other side of the piston, carries it forward with a velocity due to its pressure upon the area of the piston, which, being attached to the leading carriage, carries the train forward with it. The valve which covers the continuous opening along the main, is opened by a frame and wheels, which precede the carriage, and it is closed and sealed down as the train proceeds, by a heater, which slightly melts the wax and tallow as it passes over it. The details of all these parts were then given, and were illustrated by drawings. The paper then proceeded to notice the early attempts at using the pressure of the atmosphere, for conveying goods and passengers, the proposals of Medhurst, in 1810, of Vallance, (of Brighton,) and others. It appeared that the first intentions were to have exhausted cylinders of considerable area, within which the carriages should travel; but as it naturally was objected that the passengers might not approve of this mode of conveyance, through a continuous tunnel, means were devised for connecting the piston within the tube with the carriages traveling upon the rails outside it, and after numerous attempts, Messrs. Clegg and Samuda succeeded in the system described; and which, after being tried for some time imperfectly at Wormwood Scrubs, has been carried out practically on the line from Kingstown to Dalkey, near Dublin, a distance of 1¾ mile, up a series of inclines, averaging 1 in 115. It appeared that most of the previous attempts had failed, chiefly because the continuous valve was defective, and that Mr. Clegg suggested the use of wax and tallow, which had proved so successful as a means of hermetically sealing up the opening caused by the passage of each train. The manner of applying the power was then examined, and the adaptation of the electric telegraph, for giving the signals of the time for starting the engines, at periods along the line, was shown. The accumulation of power in the main, from forming a vacuum previously to the arrival of the train, at each division, was shown to be in proportion to the degree of vacuum which was formed. The friction of the various working parts was stated to be very small, and that on the Kingstown and Dalkey line it was scarcely appreciable. The leakage of the valve, &c., was then examined; and it was argued that the power lost by leakage was inversely as the speed of the train—for the faster the piston passed along, the less time the pipe would be under exhaustion, and, consequently, the less time would the leakage exist. Experiments upon the 15-inch main on the Dalkey line, showed that 5 horses power would be required to overcome the leakage of three miles of railway. The system was stated to be peculiarly applicable to such steep inclines as, with locomotive engines, would be called bad gradients, for so long as the steepness of the inclines was not too

great for trains to descend, without the use of the break, no power was lost; and the cost of working was no greater than on a dead level, for the whole of the additional power required to overcome gravity, while ascending the incline, was restored in descending, particularly when the planes were of great length, and at a convenient inclination, in which latter case there would be a slight saving in working an undulating line. The safety from collision between the trains was much argued upon; and it was stated to be impossible for the trains to approach nearer than three miles to each other, unless at the stations especially appointed for the purpose; single lines of railway could, therefore, be worked with safety. The cost of working was then examined, and taking for data the results of the expenses on the Dalkey line, and supposing the system to be adapted to a line of 112 miles long, similar to the London and Birmingham Railway, on which the cost of working, with locomotives, was stated to be

Per train per mile, for haulage,	15 pence.
" " for maintenance,	$8\frac{3}{4}$ "

The cost of working the atmospheric apparatus would be

Per train per mile, for haulage,	$5\frac{55}{100}$ pence.
" " for maintenance,	$5\frac{38}{100}$ "

With the additional advantage of traveling at a mean speed of 50 miles per hour, instead of between 20 and 25 miles with the locomotive system.

May 21.—A discussion upon the atmospheric railway was extended to such a length, as to preclude the reading of any papers; but as many points, both of the theory and practice of the system, remained to be examined, it was decided, that the discussion should be renewed at the next meeting, June 4th, after which a report of the proceedings will be given.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

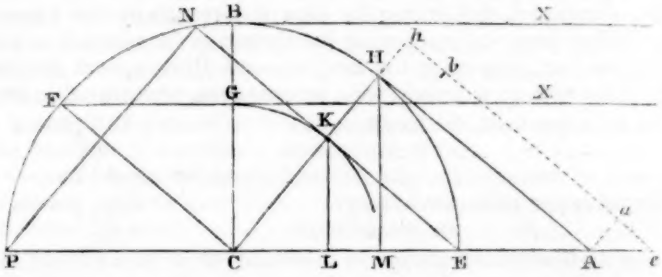
On Long and Short Connecting Rods. *By* T. W. Bakewell.

In the Journal of the Franklin Institute, for April last, page 220, notice was taken of an important error on this subject, contained in a paper copied from a foreign periodical, (the "Civil Eng. and Arch. Journ.,) where it was contended that the force transmitted through the connecting rod, in its own direction, decreased with its decrease of length, in the ratio of the cosines; and that with a short rod greater pressure came on the axis. The gross error respecting the transmission of force, was alone noticed at that time; the increase of pressure by the shorter rod being considered of comparatively slight import, notwithstanding it being said, that "it is the chief thing to be guarded against;" but no statement of the absolute value of this increased pressure is made for a given rod, nor of comparative values for different rods. The fact is admitted of an increase of pressure for friction by a short rod, and it is now proposed to exhibit, in a plain, practical way, what it is worth, carefully keeping in view that

undeviating law, that *sine qua non* in mechanics—"equality of effect" under all modes of action—for, however accute and accurate we may suppose our calculations to be, if they result not according to this law they must be wrong; and we hold the converse of the proposition—equally reliable—if in accordance with it, they must be right.

Let P E, fig. 1, be the length of stroke = 100, the crank B C = 50, then the path of the crank will be P B E = 157.08; now the piston of a rotary engine would describe this path under the constant lever B C = 50, and with a force of .6366 × 157.08 = 100 for effect.

Fig. 1.



The effective length of the crank, or "leverage," is, in all cases, equal to the perpendicular drawn from the direction of the rod to the axis, as G C, where F C, is crank, and F X, rod. The rod B X, or F X, is indefinitely long, so as to preserve its parallelism, in describing the distance of the stroke, in its own direction, = 100, and to give an effect equal to the rotary engine, will require a force of 1. multiplied into its distance, 100. The mean leverage to produce this equal effect under force 1. is 31.83, for the required force is inversely as the leverage, or the distance described. Then we say inversely, if force .6366 be lev. 50, so will force 1. be lev. 31.83, and lev. G C, 31.83 is to lev. B C, 50, as distance P E, is to distance P B E. The crank at F C, is in position for mean effective leverage = G C, 31.83.

The pressure on the axis is with the parallel rod equal 1., or what is required to meet the equal force 1. on the piston, the mean leverage being 31.83, and to increase this pressure on the axis, when using the same crank and length of stroke, we must show a less leverage under a greater force. The foregoing parallel rod X and X, is the longest possible, and the minimum is the length of the crank—and we proceed with nearly the shortest possible, or as rod 60, to crank 50,—for errors, if they exist, are brought out most vividly by extremes.

Rod H A, = 60, perpendicular to the crank, is at its maximum leverage, but at its mean of position and time, in reference to the force transmitted in its own direction, being as the cosines inversely. The mean leverage is proportional to the sines, when rod and crank are at right angles—then as sine B C 50, give lev. 31.83, so will sine H M, give lev. 24.453, or we can draw the cir. arc, as shown by the governing leverage G C = 31.83, and K L, is the mean leverage for rod 60. Leverage 31.83 × force 1. gives 31.83 for effective lever, and to

make lev. 24.453 equal, requires a force of 1.302 × lev. 24.453 = 31.83. Cosine M A, is 49.095, then inversely, rad. H A 60, is to force 1. as cosine M A 49.095, is to force required = 1.302. While it is shown that the increase of force, to the short, makes it equal for effect to the long, leverage—the terms imply that a less distance is due, but under a greater force, although the stroke = 100 remains common to both.

We believe the presentation of this point is novel, and the explanation brings with it coinciding proof of what is here advanced. The statement for explanation partakes of the suppositions, but, in effect, is actual and inevitable. When lines are used to represent forces, it is only in the directions of their lengths that they indicate values; H A, may change place parallel with itself, as by the dotted line *h a*, without expressing effect, but instead of being at *h a*, if it be found at *b e*, it will show the exertion of a force in its own direction = *a e*, while passing the horizontal distance A *e*. In this manner the distance N E = 76.825 is attained, during the stroke, equivalent in mean to the direction of the rod H A, under the force due to it of 1.302 for *a e* A, and N E P, are similar triangles, and *a e* : A *e* : : N E : P E; and dis. N E 76.825 × force 1.302 = 100 for effect. Dis. N E 76.825 is to dis. P B E 157.08 as lev. K L 24.453 is to lev. B C 50, and P E : N E : : G C : K L.

Fig. 2.

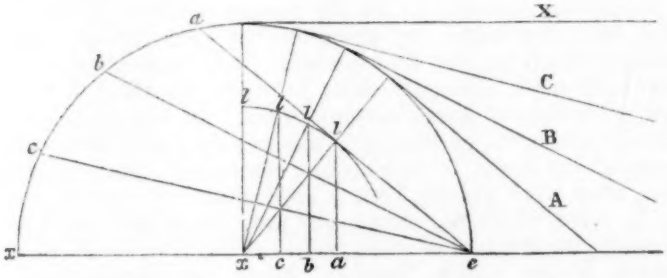


Fig. 2, delineates the relative properties of four connecting rods—in length A 60, B 100, C 200, and X infinite, stroke 100, crank 50, and force on piston 1.—arranged in tabular form, showing the leverage, multiplied by the force, equal the standard leverage 31.83; and that the force, multiplied into the distance, gives, in all cases, equal effect = 100:

Rod.	Leverage.		Force.		Equal Lev.	Force.		Dis. of Action.		Effect.
A,	*a l* = 24.453	×	1.302	=	31.83	1.302	×	*a e* = 76.825	=	100
B,	*b l* = 28.47	×	1.118	=	31.83	1.118	×	*b e* = 89.445	=	100
C,	*c l* = 30.88	×	1.031	=	31.83	1.031	×	*c e* = 97.	=	100
X,	*x l* = 31.83	×	1.	=	31.83	1.	×	*x e* = 100.	=	100

Accurately, the whole pressure for a given rod is as the leverage inversely, and the extra pressure over the parallel rod, as the difference of the given leverage, and the standard 31.83; but as these are supposed to be unknown quantities, we cannot use them. Therefore

if we take rods B, of once, and C, of twice, the length of stroke, to establish a ratio of extra pressure for friction, we find B is .118 per cent., and C, .031 per cent., which is sufficiently near the convenient ratio of the squares of the rods inversely, to make that the rule for practice. Then say the additional pressure for friction over the parallel, or infinite, rod, is, for once the length of stroke 12 per cent., for twice 3 per cent., and for thrice 1⅓ per cent.

The value of the pressure for friction is matter of opinion, but if the amount of friction with the parallel rod, exclusive of the piston, and its rod, which are not affected by the changes, be set down of its power at 15. per cent.

Once, the stroke will be	12	pr. ct.	additional	=	16.80	"
Twice,	"	"	3	"	"	=	15.45	"
Thrice,	"	"	1⅓	"	"	=	15.20	"

From these data the engineer may see the extent of power sacrificed for the convenience of a short connecting rod, which, we apprehend, is found much less than had been generally supposed.

Cincinnati, 20th June, 1844.

On the Magnesian Limestones. By Mr. C. H. Smith.

This paper was a continuation of those formerly read, treating on the sandstones and oolites; on the present occasion Mr. Smith proceeded with the subject by describing the great beds of magnesian limestone, which lie, with little intervals, from Nottingham and Tynemouth, and more especially those between Mansfield to Knaresborough, an extent of about seventy miles. In this district stone is found combining the carbonate of lime and magnesia from the lowest amount of the latter, to proportions comprising pure dolomite—of course, they vary greatly, both in appearance and quality, and that even in cases when the substances are, chemically speaking, the same:—among the best of these stones, as building materials, are the Bolsover, Roche Abbey, Barnham Moor, and Huddlestone. The first named has been tested in the Norman Church at Southwell, which remains in a state of high preservation; but much, as Mr. Smith particularly insisted upon, depends upon the situation of the beds from which the stone is raised; the remains of Roche Abbey, for example, and the church at Tukhill, both built with the stone which Sir C. Wren distinguished as second only to Portland, are in a perfect state, with all the sharpness of the mouldings preserved, whereas buildings in the neighborhood erected with the same material during the present century, but without due regard to the choice of the beds, are already in a state of decay; so also with regard to the Barnham Moor stone, many Roman remains at York are in a far better condition than the works of the middle ages in that city, not excepting the cathedral, and others at Hull, Beverly, and Tadcaster, built with the same stone. The Cadeby stone is found to decompose rapidly; a specimen used in London, perished in about fourteen years, and yet this stone is found within a short distance of Conisbo-

rough Castle, which was built with a similar stone from an adjoining hill, and remains the most perfect specimen of masonry of its age existing in this climate. The characteristics of durable magnesian limestone are its compactness, and high crystalization; those which appear earthy, and powdery, and leave white on the fingers, on being handled, are not to be trusted. The Anston quarries, which supply the stone for the Parliament Houses, were left to be the subject of a final communication.—*Trans. Soc. Brit. Arct., April 29.*

London Athenæum.

Light-House for the Island of Bermuda.

The cast-iron light-house for the Jamaica light-house commissioners, which was constructed at Bramah & Robinson's Works, three years ago, under the direction of Mr. Alexander Gordon, induced her Majesty's Treasury to apply to Mr. Gordon, for a still larger light-house for the top of Gibbs' Hill, on the main island of Bermuda, where numerous engineering difficulties have prevented the erection of a light-house in masonry. This work is now visible rising above the houses near the Waterloo Bridge Road; the contractors being Messrs. Cottam for the tower, and Messrs. Wilkison, of Long Acre, for the lantern, and the fitting therein of M. Fresnel's lenticulated apparatus of the first order. The tower is conical; the diameter at the base is 25 feet, tapering to 15 feet at the narrowest part near the top, where it is sponsoned out for the gallery, on which the lantern is to be placed. The total height, from the base to the top of the lightning rod, will be 138 feet, and when erected on Gibbs' Hill, Bermuda, will be 368 feet above the level of the sea, and the light (a fixed light with bright flashes) will be visible all round the dangerous reef of rocks to northward and westward. The outside carcase of the tower is composed of 139 cast-iron plates, their flanches being fixed together by screw-bolts and nuts. There are seven rooms, lighted by port-holes, and ports fitted with plate glass. The rooms are lined with wrought-iron, paneled in oak frames, and the ascent from the bottom to the top is by means of a spiral stair-case of iron, with oak treads. The floors are all of cast-iron, and there is in the centre a hollow column, 16 inches in diameter, for waste water pipes, and for the ascent and descent of whatever may be required in the light room and lantern, or for any of the seven rooms, thus obviating the necessity of carrying any thing up, or down, the stair-case. The whole is constructed with an especial view to the resistance of those terrific hurricanes, and other destroying causes, so common in Bermuda, and some of the West India islands. Being a perfect conductor of electricity, no thunder-storm can effect this structure; being incombustible, it cannot be destroyed by fire. Mr. Gordon's light-house at Jamaica, before mentioned, we described at the time of its temporary erection in this country. It has several times been struck by lightning, which, passing down, exhibited no other effect than the flash reaching the very top of the lightning rod, and has now been lighted for more than two years.

Ibid.

Steam Traction on Canals.

About the end of the last century—at a moment when other men would have been contented with the results obtained—before Bell, or Fulton, had shown the availability of the steam paddle-wheel for navigation, the (great) Duke of Bridgewater made an attempt to substitute the steam-tug for horse-towage on his canal. The following notice, from one of his surviving servants, substantiates this interesting fact:—"I well remember the steam-tug experiment on the canal. It was between 1796 and 1799; Capt. Shanks, R. N., from Deptford, was at Worsley many weeks, preparing it by the duke's own orders, and under his own eye. It was set going, and tried with the coal boats, but it went slowly, and the paddles made sad work with the bottom of the canal, and also threw the water on the bank. The Worsley folks called it *Buonaparte*." It may be presumed that the failure was complete, for no second trial appears to have been made. Eight coal boats were, however, dragged to Manchester, of 25 tons each, at a little more than a mile an hour.

Mechanics' Mag.

Public Works in Paris.

The *National* observes, that it is not without interest to consider the sums expended within the last twenty-four years, in the improvement and embellishment of Paris, which have rendered it one of the finest cities in the world.

	Francs
Expended on works relative to the distribution of water, aqueducts, reservoirs, and fountains, ...	30,986,347
In flagging and paving, ...	17,644,061
In purchases for enlarging the public avenues, . .	39,047,708
The construction of commercial edifices, as well as in objects of art and decoration, ...	62,984,919
In the purchase of ground necessary for those edifices,	17,802,729
Total, ...	168,465,764

Civ. Eng. and Arch. Journ.

ENGLISH PATENTS.

***Specification of a Patent granted to* J. AINSLIE, *of Redheugh, North Britain, for a new and improved mode of drying Tiles, Bricks, Retorts, and such like work, made from clay and other plastic substances.—Sealed Sept.* 30, 1843.**

The drying of clay formed into tiles and other articles, at the ordinary temperature, and rate of motion of the atmosphere, is a difficult and tedious process at many seasons of the year, so that during the

winter season the manufacture of such articles is either altogether, or in a great measure, suspended. Now it is well known that the drying depends on the rate of evaporation of the water contained in the substances to be dried, that is, on the rate at which the water can be converted into vapor, and, on the removal of the vapor so generated, the former of which depends on the temperature, and the latter on the rate of motion of the surrounding air, or of the current to which the substance to be tried is subject; also, in order to dry any substance with the greatest rapidity, the vapor must be removed as fast as it is formed, so as to prevent the evaporation being checked by the presence of accumulated vapor. Now my invention consists in the application of the above well known truths, or principles, to the manufacture of tiles, bricks, or similar articles, so as to be able to carry on such manufacture at all seasons of the year. For this purpose I place the clay, when formed and ready to place on the shelf to dry, according to the present process of manufacture, in a close chamber, heated to an artificial temperature, and through which a current of air is made to pass by mechanical, or other, means. The chamber which I have hitherto employed is built of bricks, and so situated and arranged that the clay, as taken from the machine, or mould, by which it is formed into the required shape, is placed in a wagon, or frame of shelves, which frame travels along a railway. When the frame is filled, it is run into the close chamber, and left there subject to the artificial current and temperature until the clay is sufficiently dried for burning. The time during which the clay, or plastic, substance must be subjected to the process of drying will depend on the nature and quality of the substance, and on the form into which it is put, and on the temperature and current to which it is subject. I find a temperature of about 80° of Fahr., and a current of about six feet per second, to be a temperature and velocity which answer extremely well for general purposes; but the same may be varied at the convenience of the manufacturer, only taking care not to increase the temperature and current to such an extent that the clay cracks in drying. And if, from the peculiar character, or form, of the clay, the above temperature and rate of current occasion the clay to dry unequally, or to crack, the manufacturer must decrease the temperature and current according to the circumstances of the case, so as to obviate that defect, and allow the clay to dry more slowly. The close chamber, or house, in which the clay is dried may be conveniently adapted to the rate at which the clay can be made into the required forms, so that a frame, or wagon, of dry clay may be removed from one end of the house, or chamber, to the kiln to be burnt, to make room for the introduction of the frame, or wagon, of moist clay at the other end. The close chamber may be heated by flues at the bottom and sides, or by hot water and steam pipes, or by the admission of hot air through small apertures, cold air being let into the chamber at other apertures, so as to mix with and regulate the temperature of the heated air. The warm atmosphere of the chamber may be set in motion by the draught of a chimney, or fanner, worked by steam, horse, or other power, or the current may be created by injecting, or withdrawing, the air by

pumps worked by power in the usual manner, the mechanical details to be employed for that purpose being well understood, and forming no part of my invention. The close chamber, or house, the method of heating such chamber, and the creation of the current of air through it, and the transfer of the clay to be dried through the close chamber, may be constructed, arranged, and adapted in various ways, according to the circumstances of each case. And I hereby declare that I do not claim the exclusive use of the constructions, arrangements, and adaptations hereinbefore described and referred to, except when the same are used in connexion with, and for the purposes of, my said invention of drying plastic substances in a close chamber, at an artificial temperature, and under a current of air as above described.—*Enrolled March* 29, 1844.

Lond. Reper. Pat. Inven.

Specification of a Patent granted to JAMES HARTLEY, *of Wear Glass Works, Sunderland, for improvements in the manufacture of Glass.—Sealed July* 6, 1843.

My invention relates, Firstly, to an improvement of the furnace used for flattening sheet glass.

Secondly, my invention relates to improvements in the flattening stone used in flattening furnaces.

Thirdly, my invention relates to the application of an improved bed, or surface, for glass when the same is being ground, or polished; and,

Fourthly, my invention relates to an improvement in the furnace used for heating the "nose" of crown glass before "flashing." And in order that the invention may be most fully understood, and readily carried into effect, I will proceed to explain the means pursued by me; and, firstly, in respect to the flattening furnace used for flattening sheet glass, which, being made into cylinders, such cylinders are split, and then flattened, as is well understood. According to the present construction of a flattening furnace, the workman, in flattening successive cylinders of glass in a furnace, as fast as one cylinder is placed on the flattening stone to be flattened, another is placed in the furnace to the right hand of the flattening stone, and as the fire is on the left hand of the flattening stone, as the cylinder on the flattening stone is being flattened, the cylinder of glass next to be operated on is becoming heated, but such heat is chiefly on that side next the flattening stone, that is, the side of the cylinder towards the fire, which, becoming highly heated, will, on that side, begin to drop, or flatten, whilst the other side of the cylinder, that is, the part of the cylinder most distant from the flattening stone, being comparatively little heated, will retain much of its stiffness, and, as the cylinder, on being moved on to the flattening stone, is necessarily moved with its hotter surface towards the fire, that surface will be liable to become burned, whilst sufficient heat is being obtained to the other side of the cylinder, in order to allow of that part being also flattened. Now the ob-

ject of the first part of my invention is to apply a rotary stone, on which the cylinders of glass to be flattened are successively put before going on to the flattening stone, by which the workman, before removing a cylinder on to the flattening stone, may turn it so as to bring the least heated surface towards the fire, so that when on the flattening stone the least heated side may be brought nearest the fire, by which means the side of a glass cylinder, which has become heated during the time that a previous cylinder has been undergoing the flattening process, and which is ready to be flattened, will be turned furthest from the fire, and thus will both parts, or sides, of the cylinder be more conveniently flattened, without one side being liable to become too much heated.

In carrying out this part of the invention at the right of the flattening stone, in the position where the cylinders are usually put preparatory to their being moved on to the flattening stone, I apply a flat circular stone of about ten inches diameter, on the under surface of which I affix an axis, and cause that axis to turn in suitable bearings, so that the workman may readily push the stone round with a cylinder of glass upon it.

It is well known that there is much difficulty in getting sheet glass truly level on the flattening stone, and one of the obstacles is the air which is under the glass. Now the second part of my invention consists in forming numerous small holes through the flattening stone, or bed, so that the air may readily get away from under the glass as the glass becomes more and more flat.

In carrying out this part of my invention, I form holes about an inch apart, each hole being an eighth of an inch, or less, in diameter, which I have found sufficient; but I do not confine myself thereto. By this means I am enabled to perform the process more advantageously; and although sheet glass so flattened is liable to be marked, this is not material, when the glass is to be afterwards ground and polished, and it is of great importance to obtain such thin glass, when to be ground and polished, as flat as may be.

I will now describe the third part of my invention, which relates to the application of an improved bed, or surface, for holding glass when the same is being ground, or polished. In fixing plate and other sheets of glass, in order that the same may be ground and polished, it has been usual to employ plaster of paris, and, in some cases, when grinding and polishing thin sheets of glass capable of bending, other means of holding the same on smooth and unyielding surfaces have been resorted to. Now this third part of my invention consists in applying surfaces of India rubber, on which the plates, or sheets, of glass to be ground, or polished, are to be placed; and owing to the peculiar holding character of India rubber, sheets, or plates, of glass placed thereon, will not be moved by the processes of grinding and polishing the same, whether the glass so treated be plate glass, or sheet glass, and by such means the manufacture of ground and polished plates, or sheets, of glass will be greatly improved.

The processes of grinding and polishing glass being well understood, it will not be necessary for me to enter into any description of the

machinery, or apparatus, and materials used in those processes, and it will only be necessary further to state, that the surfaces of India rubber used should be cut true on the surface which is to receive the glass to be ground, or polished. I use sheet India rubber of about three-eighths of an inch thick, and of a size depending on the size of the sheets, or plates, of glass to be ground, or polished, thereon, and I place such sheets on to a bench, or fixed surface, of wood, or other material; but I do not confine myself to these details, so long as surfaces of India rubber are used for receiving sheets, or plates, of glass to be ground, or polished; and I have found that when the weather is cold, and the surface of India rubber hardened thereby, that the surface should be slightly warmed before a fire, or otherwise.

I will now describe the fourth part of my invention. In the manufacture of crown glass, it is well known that just before introducing the glass into the flashing furnace, the "nose" of the glass is heated at a furnace constructed for that purpose, the opening out of such furnace, where the nose of the glass is applied, being called by the workman the nose-hole, and such furnace is commonly built in at one side of the flashing furnace. The air which causes the rush of flame and heated vapors through the nose-hole, is introduced below the fuel, by which means the draught through the "nose-hole" carries dust and prejudicial vapors into the glass, which is found materially to injure the surfaces thereof. Now this part of my invention consists in so constructing this description of furnace, that air may be introduced above the ignited fuel in the furnace, by which much of the injurious effects of dust, and prejudicial vapors will be prevented coming through the "nose-hole" of the furnace, when heating the "nose" of a glass which is about to be introduced into the flashing furnace. The furnace employed is similar, in all respects, to those now in use, with the addition of means of introducing air in a thin stream, or in several streams, above the ignited fuel in the furnace; and, for this purpose, I construct, on each side of the furnace, a hollow space, which opens into a tunnel from the exterior of the glass-house to admit atmospheric air, but having dampers to regulate the air passing into such hollow spaces, and these hollow spaces ascend, and open into the furnace just above the fuel, so that air will be admitted either in several streams, or in one thin sheet of air inside of the furnace, by which not only will the advantage, above mentioned, be obtained, but a greater heat will result, which can be regulated with facility by the dampers. I would remark, that I am aware that air has been, and is, introduced in various descriptions of furnaces above the ignited fuel therein. I do not, therefore, claim such application of air to furnaces generally, but this part of my invention is confined to the so constructing furnaces of the description herein mentioned, that air may be introduced above the fuel, whereby the manufacture of crown glass will be materially improved.

Having thus described the nature of my invention, and the best means I am acquainted with for performing the same, I would have it understood that I do not confine myself to the precise details, pro-

vided the peculiar character of my invention be retained; but what I claim, is,

Firstly, the improvement of the flattening kiln by the application of a stone capable of rotating horizontally for successively receiving the cylinders of glass to be flattened, before they are moved on to the flattening stone.

Secondly, I claim the employing a flattening stone perforated with numerous holes, as herein described.

Thirdly, I claim the application of India rubber for holding sheets, or plates, of glass to be ground, or polished, as above described; and

Fourthly, I claim the mode herein described of constructing furnaces used for heating the "nose" of crown glass just before introducing the glass into a flashing furnace.—*Enrolled Jan.* 6, 1844.

Ibid.

AMERICAN PATENTS.

Specification of a Patent for an Improved Reverberatory Furnace for converting mineral, or ore, into Wrought-Iron at the first operation. Granted to SIMEON BROADMEADOW, *of Manayunk, Pennsylvania, and assigned to Wm. Green, jr., of Woodbridge, New Jersey.—January 20th,* 1844.

To all whom it may concern: Be it known, that I, Simeon Broadmeadow, of Manayunk, in the county of Philadelphia, and state of Pennsylvania, have invented a new and improved reverberatory furnace, for the purpose of directly converting mineral, or ores of iron, into wrought-iron, at the first operation, by the process of puddling, using either anthracite, bituminous coal, or other fuel, for that purpose; which furnace I also use for the puddling of pig-iron, or of iron in other states, which is to be submitted to that process, and likewise for the melting, or heating, of metals for various purposes; and I do hereby declare that the following is a full and exact description thereof:—

My improvement in the reverberatory, or puddling, furnace, consists in the so constructing it as that the hearth of the furnace shall be heated both on its under and upper sides. For this purpose I construct a fire chamber, in which the fuel rests upon grate bars directly under the hearth of the puddling furnace, there being an ash pit under said grate bars, such fire chamber and ash pit being in the ordinary form. The direct heat of the burning fuel which is contained in the fire chamber, is, consequently, made to operate on the under side of the hearth, and the heated air and flame ascend through a flue space at the rear end of the fire chamber, then along the puddling compartment, to the front of the furnace, and thence back along a flue over the roof thereof leading to the chimney, which is to be elevated in the ordinary manner to create a sufficient draught.

In the accompanying drawing, fig. 1, is a front elevation of the furnace; the masonry which encloses it, and the chimney being

omitted for the purpose of showing the outline of the interior. Fig. 2, is a vertical section through the middle of the furnace from front to back. A, is the ash-pit; B, the fire-chamber; C, the hearth of the puddling furnace D, into which the heated air and flame pass through the flue space E, and operate upon the material within the furnace in the usual manner; F, is the roof of said furnace; the hearth and roof should be formed of suitable fire stone; G, is a flue above the roof stone, leading to the chimney H; I, represents a front door to the puddling furnace, but the main working door is to be made at the side, as seen at I', this being its usual place; J, is the door of the fire chamber for supplying fuel; K, is a basin at the front of the hearth, and L, a tap hole for the removal of slag, &c.: as it is desirable to keep the hearth at this part well heated, I sometimes so construct the fire chamber as to allow it to project a foot, more, or less, in front of the furnace, by which means this end is effectually accomplished. The lower part of the basin may be strengthened by giving the hearth stone the form shown by the dotted lines *a, a;* M, is the grate, and N, level of the ground.

Fig. 1.

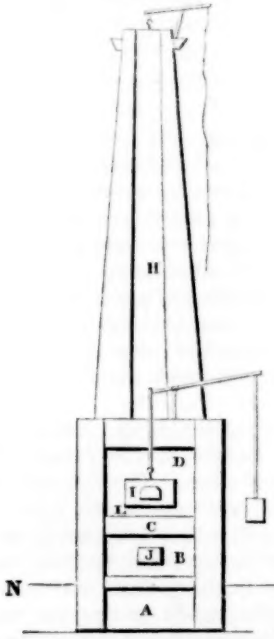
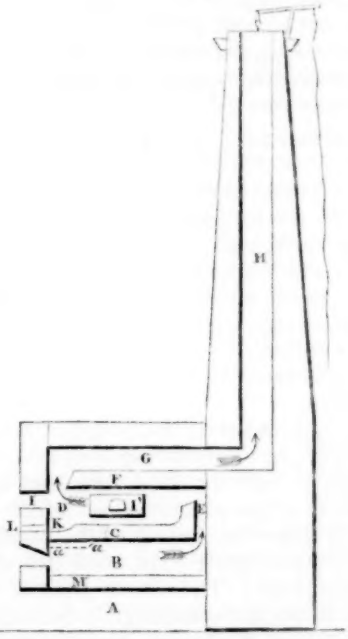


Fig. 2.



Scale, one-eighth of an inch to a foot.

When this furnace is used for the purpose of converting mineral into wrought-iron directly from the ore, said ore is to be finely pulverized, and thrown upon the hearth, which must be heated to whiteness; in about half an hour the mineral will be fused, and it is then to be treated in the same manner as when puddling pig-iron; by this

means the sulphur and other volatile matter contained in the ore will be driven off, and the ore will be subjected to the full action of the heated air. Most kinds of ore may be treated in this way without the addition of any flux, or of carbonaceous matter; but where the ore is refractory, and does not fuse readily, from containing an excess of oxygen, a small portion of charcoal may be added thereto. When the ore is too fusible, owing to its containing an excess of carbon, I add the scales of iron, or some analogous substance, such as the highly oxidized ores, as is sometimes done in the puddling of pig-iron. No rule can be given for this, but the judgment of every competent iron master will supply all the information that is necessary. Most commonly, as before remarked, the metal will be brought into nature without any such addition to the iron. When the mineral, or pig metal, has been thus heated until it approaches the melting point, the fire is to be slackened, until it is reduced nearly to a red heat; in this state the ore, or the metal, is to be worked with a scraper and paddle until the mineral, or metal, shall have become, as the technical phrase is, sufficiently *dry*. At this period the heat is to be raised, and, when the welding of the mineral, or metal, commences, it is to be balled into suitable sizes, either for the hammer, or the rollers.

Having thus fully described the manner in which I construct my puddling furnace, to be used either for the purpose of converting mineral, or ore, directly into the state of malleable, or wrought, iron, as above set forth, or for the puddling of pig metal, or other iron with a like view, and also for the purpose of melting, or heating, of iron, or other metals, what I claim as new, and desire to secure by letters patent, is the constructing and using of a reverberatory furnace that is heated by means of a fire chamber, situated below its hearth, or floor, and from which the flame and heated air are conducted over its top, so as to heat it as well below as above; the respective parts of said furnace being combined, arranged, and operating, as represented and described.

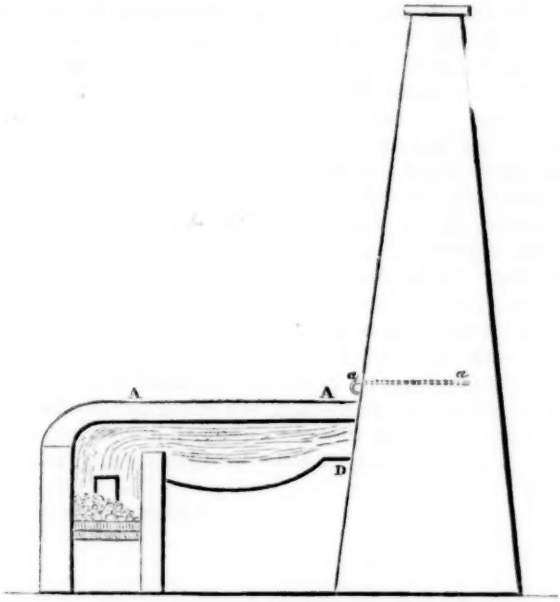
SIMEON BROADMEADOW.

Specification of a Patent for manufacturing Malleable Iron directly from the ore, in a Puddling Furnace. Granted to SIMEON BROADMEADOW, *of the city of New York.—May 30th,* 1844.

To all whom it may concern: Be it known, that I, Simeon Broadmeadow, of the city of New York, in the State of New York, have invented a new and useful improvement in the process for manufacturing iron; by means of which improvement I am enabled to obtain malleable iron directly from the ore, by treating the same in a puddling furnace; and I do hereby declare that the following is a full and exact description thereof:—

The form that I, in preference, give to my furnace, is somewhat different from that usually given to the puddling furnace, as will be seen by reference to the accompanying drawing, which represents it as having one of its side walls removed for the purpose of showing

the form of the interior. A A, is the arch, or roof, which, instead of curving down as it approaches the chimney, rises regularly from that part which is above the fire chamber, as it approaches the stock, which it may do at an elevation, say of about ten degrees; it may, however, pass horizontally, or even be slightly depressed, without materially interfering with its action; the object of giving to it this form is to prevent its taking the character of a reverberatory, as the reflecting of the flame and heat so as to cause them to reverberate, or impinge, upon the ore, converts the large portion of it into slag, instead of reducing it into malleable iron. I also elevate the hearth of my furnace at its rear end, and prefer to do this to an extent greater than that of the elevation of the roof; this elevation is shown at D.



The object thereof is to contract the throat, or opening, from the furnace into the flue, so as to make it much less than in the ordinary reverberatory, which is usually about two feet, or two feet six inches, whilst I reduce its height, between the floor and the roof, to about one foot. In the lower part of the chimney, as at *a*, *a*. I place a sliding register, or damper, which I can close at pleasure, so as to retain and regulate the heat; such regulation being essential to the success of my process. In a furnace, so constructed, the mineral, and the metal obtained therefrom, will be sufficiently heated to produce the intended effect; but the form of the furnace may, as above indicated, be varied to a considerable extent without materially interfering with its use; and there have probably been puddling, or other, furnaces constructed, which, under due management, might answer the pur-

pose equally well with that described. I do not intend, therefore, to make any claim to the particular form of the furnace which I have described, but only to indicate the main conditions necessary to the success of the process.

In my process of reducing the mineral to the metallic state, I do not use any of the earthy, or other, fluxes which are employed in the smelting of iron, nor do I, of necessity, mix therewith any carbonaceous matter, as has been uniformly done in the attempts heretofore made to manufacture malleable iron directly from the ore. The most notable of these is the process for which letters patent were obtained in England by W. N. Clay, dated on the 31st of March, 1841, and published in the "Repertory of Patent Inventions," for that year. In that patent a claim is made to "the mode of manufacturing wrought, or malleable, iron in reverberatory furnaces from iron ore, by combining therewith twenty-eight per cent., or upwards, of carbonaceous matter." In my process, on the contrary, I employ the ores of iron alone, by mixing together, in due proportions, such ores as, by their chemical composition, are calculated to react upon each other when duly heated, and to bring the metal contained in each of them into the malleable state, I take any of the ores which are known as oxides of iron, which I reduce to coarse powder, and with this I mix a due proportion of the ore known as a carburet of iron, also in powder; this mixture I put into my puddling furnace, and by means of anthracite, or other fuel, I subject it to the proper degree of heat for effecting the reduction. The mass so placed in the furnace, I do not stir, but leave at rest, until I find that it is brought into a state in which it is prepared for balling, which condition is produced in consequence of the union of the carbon of the carburet with the oxygen of the oxide, and the consequent production of particles of iron in the malleable state.

When charcoal, or other carbonaceous matter, is mixed with the ore which is to be reduced, the carbon will begin to combine with the iron in the oxide which is to be reduced, before the oxygen of said oxide is so far disengaged as to be ready to combine with it, and the metal will become highly charged with carbon, and the whole contents, will, consequently, be converted into a fluid mass, and this may occur notwithstanding the utmost care on the part of the operator; a very slight deviation in making the mixture, or in the heat to which it is subjected, converting the materials into slag. But when this mixture consists entirely, or nearly so, of the ores to be reduced, as above described, there may be a considerable variation in the temperature without deteriorating the mass, the carbon of the carburet, and the oxygen of the oxide, being given out simultaneously, and these, by their affinity, combining with each other, the iron of both the ores will be left in the metallic state, requiring only to be balled up.

It will be manifest to any one acquainted with the nature of ores, that in mixing them no proportionate quantities can be designated, as scarcely any two ores will be found to be identical in composition; but the proportionate quantities may be learnt from analysis, or will

readily be ascertained by experiment in the hands of a competent iron master.

Although the addition of carbonaceous matter is not necessary in my process of reduction, I do not interdict its use, as it is manifest that a deficient proportion of carburet might find its compensation in such addition, but this would be only a variation of, and not a departure from, the principle upon which I proceed. When the iron is ready for balling, the slag is to be removed, and the balling is to be effected in the ordinary way; the working and feeding doors, the tap hole, and the general appendages of furnaces for this purpose being such as are well known.

Having thus fully set forth the nature of my improvement, in the process for obtaining malleable iron directly from the ores of that metal, what I claim as new therein, and desire to secure by letters patent, is the effecting of such reduction by mixing in due proportion the ores known as oxides, and as carburets of iron, and by exposing them to a proper temperature in a puddling furnace, without the addition of any of the ordinary fluxes, or the necessary admixture of carbonaceous matter therewith.

SIMEON BROADMEADOW.

Specification of a Patent for an improvement in the manufacturing of Steel. Granted to SIMEON BROADMEADOW, *of the city of New York.—May 25th,* 1844.

To all whom it may concern: Be it known, that I, Simeon Broadmeadow, of the city of New York, in the state of New York, have made a new and useful improvement in the construction of the furnace for converting iron into steel by cementation, and in the process of manufacturing such steel.

In the ordinary mode of constructing the converting furnace, the bars of iron, after being piled in the coffer, or oven, in combination with carbonaceous matter, to the proper height, are covered with a stratum of fire clay and sand, or some analogous substance, which has to be renewed every time the oven is charged. My improvement in the structure consists in the using of a permanent roof of fire stone, or fire brick, in place of the temporary covering heretofore employed. I also use a sliding shutter, which is placed in front of the furnace, so that it may be brought down as required for a purpose to be presently made known.

My improvement in the manufacturing of the steel, after the process of cementation has been completed, consists in the taking of the bars first from the upper part of the convertory, whilst they are at the highest temperature to which they are to be brought, and subjecting them immediately to the action of tilting, or of rolling, without the necessity of re-heating. To do this, a part of the upper layer of bricks which enclose the converting oven is first removed, so as to enable me to draw out the upper bars, and as the bars are successively operated upon, the bricks are further removed, until the whole con-

tents of the convertory have been tilted, or rolled. As this process goes on, the sliding shutter is brought down so as to enclose the part from which the bricks have been removed. By this procedure several advantages are attained in the process of manufacturing steel. Under that hitherto followed, the whole charge has been allowed to cool down before removing the steel from the convertory, and this necessarily resulted in great loss of time; the bars after being removed had to be re-heated, in order to their being tilted, or rolled; by this re-heating time was consumed, and the steel actually injured, it being a well established fact, that every time steel is highly heated, it is deteriorated. The steel manufactured by my improved process, has proved to be very superior to that made from the same iron in the ordinary way; it has, in this particular, exceeded the anticipated benefit.

In the accompanying drawing, fig. 1, is a front view of the converting furnace, the temporary brick work which is used to enclose the coffer, or oven, and likewise those that enclose the flues A, A, the arch B, and the chimney stack C, being removed. D, is the roof of fire stone, or fire clay, which extends over the whole top of the coffer, or oven, E. Fig. 2, shows the top of this roof in plan, being a horizontal section of the furnace, in the line X, X, of fig. 1; D, is the roof stone, and A, A, the flues leading from the fire chamber into the arch, as usual.

Fig. 1.

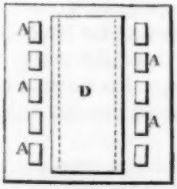
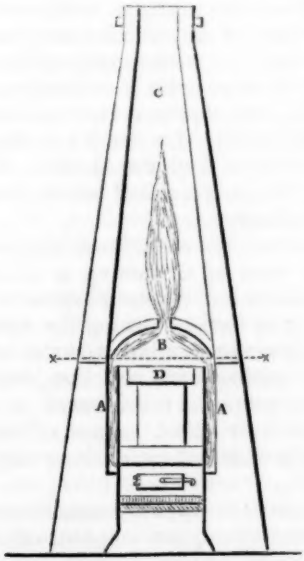


Fig. 2.



Having thus fully described the nature of my improvements in the construction of the furnace for converting iron into steel, by cementation, and also made known my improvement in the process for

manufacturing steel, after the cementation has been completed, what I claim therein as new, and desire to secure by letters patent, is the improvement herein described of taking the steel from the oven in its heated state, and subjecting it to the action of rollers, or of the tilt-hammer, without the necessity of reheating the bars, by which improvement said manufacture is greatly facilitated, and the quality of the steel much improved.

SIMEON BROADMEADOW.

[Specifications written by the Editor.]

MECHANICS, PHYSICS, AND CHEMISTRY.

Extracts from the Report of Capt. G. W. HUGHES, *of the Topographical Engineers, to the Secretary of War, relative to the working of Copper Ore.*

(Continued from page 43.)

I shall now resume the consideration of the treatment of the mattes at the point where they were ready to undergo the last operation before being refined, viz., *the roasting*. The object of this operation is to separate the most oxidable metals with which the copper is still mixed. The common roasting furnace is used for the purpose, or one that receives a constant stream of air. The last matte obtained, having been run into pigs, is exposed at a red heat to a current of air; the duration of this roasting continues from 12 to 24 hours, according to the lesser, or greater, proportion of foreign metals in the crude copper. The fusion must not take place till the roasting is finished; from the fusion, the copper is run into moulds of sand; the interior of the pigs, thus obtained, exhibit a porous texture, which is caused by the escape of vapor from the moulds. Their surface is covered with black blisters; hence it is called *blistered copper*. In this state it is prepared for the refinery.

When the ores of pyritous copper are very poor, they are calcined, with the view of extracting a portion of the sulphur; and the mass is then lixiviated, for the purpose of dissolving the sulphates of copper and iron formed during the calcinations; old scrap iron is then thrown into the solution, and the sulphate of copper is decomposed, its acid uniting with the iron, which is, at the same time, oxidized, while the copper is precipitated in a spongy metallic state. In this condition it is called *copper of cementation*. From the remaining solution is obtained crystalized sulphate of iron, or the *copperas* of commerce.

Cementation copper is sometimes procured from reservoirs, where the natural solutions of sulphate of copper, which have flowed through subterraneous caverns containing furruginous ores have been collected. The Rio Tinto mine, in Spain, is a notable instance of this mode of obtaining copper. This mine was worked by the Romans, and subsequently by the Arabs and Moors, who, on their expulsion from

Seville, destroyed the works. In 1787, the experiment was tried of extracting copper from its vitriolic waters. The attempt was successful, and from that time to the present, the mine has maintained a great celebrity. It yields annually 1800 quintals* of copper, and consumes 2400 quintals of iron furnished by the iron works of Pedroso. This copper is perfectly pure, and may be employed in alloying the precious metals. The greater portion of it is, however, manufactured at the Seville foundry.

The management of ores of the oxides, or carbonates, of copper is extremely simple. It is, indeed, sufficient to calcine and smelt either of those ores with charcoal, in cupola furnaces, to extract the crude copper.

Dr. Houghton, in his interesting report on the geology of Michigan, states that the carbonates of copper are the predominating ores of that metal found on the southern shores of Lake Superior. The ores from the same region recently exhibited to me by General Cunningham, United States agent of mineral lands, and other gentlemen, consisted of native copper, the red and black oxides, and the hydrosilicate, or *crysocolla*, which, indeed, appears to be the predominating ore. According to Ure, it is green, or bluish green; specific gravity 2.03 to 2.16; scratched by steel; is very brittle; affords water by heating, and blackens; is acted on by acids, and leaves a siliceous residuum. Solution becomes blue with ammonia. Its constituents are silica 26, oxide of copper 50, water 17, carbonic acid 7. When pure, will yield from 40 to 44 per cent. of metal. It is infusible at the blow-pipe alone, but melts readily with borax. This description will apply to the specimens from Lake Superior; but I have never heard of its having been found elsewhere in sufficient quantities to be worked as an ore of copper. I see no reason, however, why it might not be easily reduced, using limestone, or fluate of lime, as a flux. The red oxides shown to me were not very rich, nor were they difficult of reduction. On the whole, I should think they might be worked profitably. The black oxides seemed to be much richer; but I could procure none for experiments.† The predominating ore at Mineral Point, Wisconsin, is the yellow sulphuret, mixed with the *blue carbonate*.

H. C. Strom, State officer of mines in Norway, in drawing a parallel between the British and continental methods of smelting copper, gives the decided preference to the latter, more particularly to that modification of the continental mode practiced in Norway.‡ It appears that at Roros, very accurate experiments have been made, to ascertain the actual expenses of fuel, labor, and transportation, during the smelting operations. At Freyberg, it has been ascertained that the smelting power of *coke*, as compared with *charcoal*, (half pine, half fir,) was in volume as 3 to 1. Taking this as a basis, he says, we may draw the following deductions:—

* The quintal is equal to 112 pounds, or one cwt., English.

† Since writing the above, Gen. Cunningham has kindly furnished me specimens of black oxide of copper, but I have not yet tested them.

‡ The English furnaces are reverberatory, or horizontal; the continental are vertical, or blast, furnaces.

"That one mining ton, 2,352 pounds of pyritous copper ore, averaging, in volume, 19.5 cubic feet, and containing 8 per cent. of pure copper, may be reduced to coarse copper of 85 or 90 per cent. with 38.09 cubic feet of coke, or, in weight, (taking Newcastle coke, of middle size, and allowing 5 per cent. loss,) 1,008.2 pounds."

Mr. Strom supposes that the Norwegian process would require for the calcination of one ton of ore about 350 pounds of coal. He says it appears, by careful analysis, that the slags at Swansea contain from 0.765 to 0.30 pounds more copper, per 100 pounds, than at Roros; and that the difference between the two methods, in loss alone, amounts to 2*s.* 6*d.* per ton of ore in favor of the Norwegian. He gives the following estimate of the amount of fuel necessary to reduce a ton of ore to refined copper, viz.:—

	Lbs. of Coal.
The quantity used in calcining, . . .	350
1,008.2 pounds of coke, ...	2,016.4*
To this is to be added, for refining, . .	150

Thus the total quantity of coal to reduce a ton of ore, at 8 per cent., to refined copper, by the Norwegian method, would be 2,516.4 pounds of coal, or nearly 107 to 100 of ore.

MM. Dufrenoy and Elie de Beaumont give the following estimate of the expense of making one ton of copper in South Wales:—

12½ tons of ore, yielding 8½ per cent. .	£55	0*s.*	0*d.*
20 tons of coals, ...	8	0	0
Workmen's wages, rents, repairs, &c., .	13	0	0
Total, ...	£76	0	0

The "*standard*" (value) of fine copper varies from £100 to £120 per ton.

Mr. Strom states the excess of coal on the English system, over the continental, at 29 tons per 100 tons of ore; and he estimates the expense of reducing a ton of ore to coarse copper at 11*s.* 6*d.*, and the refining at 1*s.* 6*d.*, making in all 13*s.* The continental method would cost 7*s.* 2*d.*; making a difference of 5*s.* 10*d.*

He thinks that the principal advantage of the Norwegian process consists in the calcinations; but he also contends that the vertical blast furnace possesses a considerable superiority over the reverberatory furnace; and he suggests that the universal use of the latter in England, is probably owing to the want of water power, and to the fact that the application of coal, or coke, for this purpose is of recent introduction. In conclusion, he observes: "Such being the case, and knowing the reluctance with which alterations were admitted into practice in former days, we may cease to wonder that it has been only within the last fifty years we have acquired the certain conviction that by the continental method a third, and sometimes a greater proportion, of the labor and consumption of fuel incurred in smelting the same ore has been unnecessary, and that no objection has arisen against the use of the reverberatory furnace."

* This corresponds very nearly with the yield of Newcastle coals, but not at all with the Welsh coals, which often produce from 70 to 80 per cent. of coke.

The Refining of Copper.

The process of refining copper is conducted in a reverberatory furnace, the hearth of which is composed of charbonnaile,* or of quartz. The object of this operation is to evaporate all the volatile substances contained in the coarse copper, such as sulphur, arsenic, antimony, &c., and to oxidize and convert into scoriæ the fixed substances, such as iron, lead, &c., in such a manner as to allow the least possible waste of metallic copper. This operation is not very rigorous; but the small portion of gold, or silver, (which it sometimes contains) that will not oxidize is of no injury to the copper.

At the celebrated copper foundry of Seville, in Spain, where the very best quality of metal is produced, the following processes are observed:—

Before heating the blast furnace, whether after its renewal, or the reconstruction of its hearth, the whole interior is plastered with mortar of fire clay, or pulverized brick, for the purpose of closing the cracks, and preserving the vaults from the first impression of the fire.

In arranging the charge, rows of fire brick are placed edgewise on the hearth of the furnace, and on the brick are deposited successive layers of pigs of black, or crude, copper, crossing each other, with sufficient spaces between the pigs to permit the flame to circulate freely through, and amongst the different layers, and to penetrate to the hearth, which it dries and heats sufficiently to produce a gradual fusion of the metal. Care is taken not to obstruct the vent near the flues, and not to place the pigs nearer than five, or six, inches to the walls of the furnace.

The pigs forming the first bed, or layer, are carefully placed, so that they may not, in falling, break up the hearth.

The weight of the charge is proportioned to the capacity of the furnace, and so disposed that the level of the metallic vat, or bath, may be about one inch above the tuyere of the blast; for if it should be higher than this limit, the metal would attach itself to the tuyere, and thus obstruct the blast; and if it should be lower, the current of air would strike the surface of the molten metal imperfectly; in consequence of which the refining process would be much retarded, by leaving the oxidation and volatilization of the foreign substances incomplete.

The judicious management of the fire in a furnace which has been recently repaired, consists in advancing the heat very slowly for the first three hours with very dry wood, to gradually deprive the hearth, or charbonnaile, of its moisture, and to soften the copper, so that it may fuse almost imperceptibly.

If, at the termination of these three hours of heating, it is noticed that the copper has become red, and that the bottom, or hearth, of the furnace has not yet lost its moisture, it will become proper to continue this slow combustion until every part of the furnace has acquired the

* This substance is composed of one-third refractory clay, one-third refractory sand, and one-third pulverized carbon, (in volume;) the whole moistened, and thoroughly worked till it forms a consistent and homogeneous material, which vitrifies into a strong glassy mass by an intense heat.

same temperature with the copper. If, finally, this equilibrium of heat is not observed to take place, it will be necessary to suspend the fire for a short time, and to seal hermetically all the outlets, or fissures, of the furnace, in order to compel the copper to divide with it, its excess of temperature.

When the same degree of heat is thus produced in all parts of the furnace, the blast is forced; and, at the end of seven, or eight, hours, the metal begins to melt, and is soon after covered with a great quantity of scoriæ.

If it should be considered desirable to increase the intensity of the fire, it must be recollected that this object will not be attained by overloading the grates with fuel; otherwise you obtain smoke only, which lowers rather than increases the temperature. The best guide to follow, in this respect, is the flame, which, when there is neither excess nor deficiency of combustible, fills the entire capacity of the furnace, and presents a beautifully intense red appearance.

When the bath has become fluid, and the scoriæ sufficiently liquid to give up the copper which they retained, they are removed with a long handled rabble. If they appear refractory when subjected to a strong blast, they may be brought to a suitable vitrification by mixing limestone, or calcareous clay, with them for a flux. If, on the contrary, they become too fluid to be raked off, which is often the case, they may be thickened by throwing in refractory materials similar to those of which the hearth is composed. After having freed the bath of all impurities, the bellows are put in action.

Soon after the metal is melted, charcoal is ignited in three large iron vessels, lined with loam, to prepare them for the reception of the copper, which is to be converted into rosettes.

Ordinarily, soon after the bellows are put in motion, the evaporation of mineral substances is so abundant as to produce ebullition in the bath; some of the drops rise even to the vault of the furnace, while others escape from the doors, and fall condensed in a drizzling rain of small spherical globules. When this phenomenon appears, the refining goes on well; when it disappears, the operation is drawing to an end.

The most certain indication of the progress of refining is found in a small sample of copper, called a *montre*, which is taken from time to time from the bath on the heated end of a polished steel rod, plunged two, or three, inches deep into the bath, and then immersed in cold water. The montre is detached from the rod by a few smart blows of a hammer; and an opinion is formed of the degree of purity it has attained from its density, color, and polish. But these samples are never drawn till the drizzling of metallic globules ceases. The first montres withdrawn are thick, the surface is uniform, smooth, and of a red color, resembling old copper coins; the interior is unequal, of a leaden color, and dotted over with white and yellow specks. As the refining process advances, the small holes observed in the first montre gradually disappear, the outer surface becomes darker, the inner of a more uniform color, and less and less marked with spots. Finally, when the metal has acquired the greatest degree of purity

that this operation can give, the sample acquires a dark crimson appearance, slightly tinged with a maroon shade; at the same time, the interior is of a deep and uniform red color, unmixed with spots of any kind. In this state, which indicates the greatest possible degree of purity that copper can attain, it is flexible, and its fracture presents a close, soft grained appearance of an obscure red color.

The process must be stopped at the proper time, otherwise a small quantity of oxide of copper would be formed, rendering the metal hard, brittle, and incapable of perfect lamination.

Having ascertained, by an examination of the last montre, that the copper has been sufficiently refined, the action of the bellows is stopped, the opening of the tuyere is closed, the nap is pierced, and the melted copper flows into the vessel, (prepared for its reception,) from which the burning charcoal has been removed. When the receptacles are full, the tap-hole is reclosed with loam. When the surface of the metal (which has been drawn off into the basins,) is covered with a solid crust, it is slightly sprinkled with water, and when about two inches thick is raised up by means of hoops to let the drops drain off, and is then removed from the furnace. This operation is continued till all the copper has been taken off. These layers are called "*rosettes.*" They are cooled suddenly by plunging them in water, when they assume a beautiful red color, owing to the removal from their surface of a slight film of oxide of copper, by the volatilization of the water. If the metal should be dipped into water before it has become completely solidified, dangerous explosions may happen; and if left too long cooling in the open air, it becomes peroxidized on the surface, and does not assume those beautiful colors which the protoxide imparts.

Each refining operation produces, in from 14 to 15 hours when the hearth is new, and in from 9 to 10 hours when it is old, $1\frac{7}{10}$ ton of fine copper, with the consumption of $\frac{4}{5}$th of a ton of dry wood.

Care is taken, after each "drawing off," to close every fissure by which the exterior air might penetrate, in order to produce a gradual cooling of the furnace, and thus to avoid the cracking of the vitrified interior casing which might be caused by a sudden refrigeration.

When it is deemed expedient to renew the hearth, or the interior of the furnace, the old work is broken up, and the materials carefully washed, for the purpose of extracting the little metal which it always contains; small quantities of copper, which have been sublimated, are also extracted from the flues, and other parts of the furnace.

Dr. Ure remarks, that "when a little oxide of antimony and oxide of copper are combined with copper, they occasion the appearance of micaceous scales in the fractured faces. Such metal is hard, brittle, yellowish within, and can be neither laminated nor wire drawn. These defects are not owing to arsenic, as was formerly imagined, but most probably to antimony, or to lead, which is sometimes used in refining copper. They are more easily prevented than remedied. According to Mr. Frèregean, proprietor of the great copper works of Vienne, in Dauphiny, too low a temperature, or too much charcoal gives to the metal a cubical structure, or that of divergent rays; in

either of which states it wants tenacity. Too high a temperature, or too rapid a supply of oxygen gives it a brick-red color, a radiated crystalization without lustre, or a very fine grain of indeterminate form—the last structure being unsuitable for copper that is to be worked under the hammer, or in the rolling press. The form which indicates most tenacity is radiated with minute fibres, glistening in mass. Melted copper will sometimes pass through, successively, these three states in the space of ten minutes."

The furnaces employed at Seville and Swansea, in the various operations connected with the reduction of copper ores, are all of the reverberatory kind, and may be considered as divided into five species:—

1st. Calcining furnaces.
2d. Melting furnaces.
3d. Roasting furnaces, or "roasters."
4th. Refining furnaces.
5th. Heating furnaces, or "heaters."

Mr. Vivian, the proprietor of the Ha'ford Works, South Wales, has effected many important improvements in the construction of furnaces, amongst which may be mentioned a furnace of three tiers of hearths, which answers the double purpose of calcination and of fusion at the same time—thus very much simplifying these tedious operations. In the roasting furnaces he has succeeded, by an ingenious contrivance, in introducing a continuous current of hot air over the impure metal, by which means oxidation is much facilitated, the smoke is consumed, and the sulphur dissipated.

In the preparation of this paper I have had frequent occasion to regret that the necessity of avoiding the difficulty which always attends the engraving of drawings accompanying executive documents, has often compelled me to render the description of mining operations, furnaces, machinery, &c., much more obscure, and less satisfactory than they might be if accompanied with the usual graphic illustration necessary to present the details of those subjects clearly to the understanding.

At Ha'ford, the refining operation is not widely different from that already described as being practiced at the foundry of Seville.

When the metal is melted, a workman opens the door, and removes with a rake the few scoriæ which may float on the surface of the bath. An assay is then taken from the bath with a ladle, and is broken in a vice, when cool, to show the state of the copper. From the appearance of the assay, of the bath, and of the fire, an opinion is formed of the condition of the copper, and of the quantity of dry wood and charcoal which must be added to make it malleable.

When the refining process commences, the copper is brittle, and of a deep purplish red color. Its grain is open, coarse, and rather crystaline.

The metal is next covered over with wood charcoal, and stirred continually with a wooden pole; the gas, or vapor, escaping from the coal produces quite an ebuilition. The charcoal is added as often as it may be necessary to keep the metal always covered until the refin-

ing be accomplished, which fact is ascertained by an inspection of the samples frequently taken from the bath. When the grains become very fine, and the assays (half cut through, and then broken,) present a soft, silken fracture, of a fine red color, the process is finished, and the melted copper is removed in *cuvettes*, and run into moulds. The ingots thus formed are about 18 inches long, 12 inches wide, and 2 inches thick.

When the copper is very difficult of refining, lead is added, which acts as a purifier, and assists the oxidation of the iron and other metals which may be present; but it is essential that all the lead itself should be removed by oxidation, otherwise it will hinder the lamination of the copper.

The refining process usually lasts 20 hours. In the first six it undergoes a kind of roasting, and then melts; the next four hours fit it for refining, at which time that operation, in fact, begins, and consumes four hours more; and six hours are required to arrange the mould, to cast the ingots, and to allow the furnace to cool. The charge varies from 3 to 5 tons, and the quantity of fine copper produced at these works per week, is from 40 to 50 tons. According to Mr. Vivian, the consumption of fuel amounts to from 15 to 18 parts of coal to one of refined copper.

Copper of commerce is manufactured into various forms, according to the different objects for which it is intended.

That used in making brass is granulated, for the purpose of presenting a greater surface to the action of the zinc, with which, in this state, it more readily unites. There are two kinds of granulation, the one, of which we have just spoken, is called *bean shot*. It is formed by pouring the melted copper into a ladle, pierced with small holes, and allowing it to fall into a basin of hot water, by which means it is converted into small, smooth, globular grains. If the water is cold, it forms irregular ramified grains called *feathered shot*.

Copper is sometimes run into *ingots*, weighing about six ounces each, intended for the East India market, and is then called *Japan copper*.

The most common form, however, of copper of commerce is that of sheets, into which shape it is brought by rolling the heated ingots between powerful cylindrical rollers. These cylinders are about three feet long by 15 inches diameter, and are so arranged that the distance between the upper and lower rollers may be regulated at pleasure, and adjusted by means of screws to the desired thickness of the metallic plates.

When the copper ingots have been heated to a dull red color, they are removed from the furnace, and passed through the rolls; but they cannot be reduced to sheets without repeated heatings and rollings, because the metal cools rapidly, and acquires, by pressure, a texture which resists further lamination.

The manufacture of copper at all the Swansea works is conducted on essentially the same principles (slightly modified to suit peculiar circumstances,) as those described by Mr. Vivian, in the Annals of Philosophy.

The next most important works, after the Ha'ford works, (owned by the Messrs. Vivian,) belong to Williams, Foster & Co. The first thing done is to form a nearly uniform mixture of pulverized ores, as they are unloaded. This is rather important, because the ores being different in constituents and richness, they act often as fluxes for each other. The average yield of these mixtures is about eight and a half per cent.

The ore,* having been thus pulverized, and uniformly mixed, is carried by railway and steam power up to the hoppers, from whence it is passed into the furnaces, (below the hoppers) and there subjected to a high degree of heat for twelve hours, by which time it is well calcined. This drives off much of the arsenic and sulphur with which it is combined. It is then carried to another furnace, where it is melted. The slag is lighter, floats on top, and is the first drawn off. Fluxes are seldom necessary, and never so, except with a very refractory ore, when fluate of lime is used for that purpose. The first slag, which is usually remelted, generally acts as a sufficient flux of itself. It is often seen crystalized in various forms, exhibiting a beautiful pavonine play of colors. The crude copper is now broken up and remelted, with a current of air passing through it, for the purpose of oxidizing the iron with which it is mixed, and is then drawn off into a tank of cold water to granulate. The water is prevented from becoming hot by a cold stream continually running through the tank. The object of the granulation is to separate the metal into small globules, so that the fire may circulate freely through and amongst it, when again subjected to its purifying action. After granulation, it is again roasted, or calcined, for thirty hours, and is then removed to another furnace, when it is melted with a draught of air passing through it, as before, to effect a still further oxidation of the iron; from this furnace it is drawn off and run into pigs. It is then again broken up, remelted, and, in a fluid state, conducted into a refinery among burning charcoal, from whence it is run into ingots, or into plates about 18 inches square by two, or three, inches thick. This is sometimes the copper of commerce; but it is usually rendered malleable and ductile by the following processes, viz., it is clipped, heated, rolled, and cut into sheets, say two feet long; again heated, and rolled; then again heated, *doubled*, and rolled, and sometimes (depending on its quality,) again rolled without additional heating.

This is called finishing. It is then immersed in a bath of uric acid, for the purpose of brightening the metal, and removing the appearance of impurities from the surface. It is then put into a furnace, then immersed in cold water, from which it is brought out bright. It is then taken to a machine, where its four edges are clipped smooth, leaving it about three feet long, one wide, and in thin sheets. It is then assorted, weighed, and stamped with the weight per square foot, which ranges from 10 to 20 ounces.

In some of the establishments the processes are more simple; but I should doubt their being so efficient: as, for instance, the metal is granulated from the first melting direct, and, after the second melting, it is not broken up, but remelted in mass; and, in rendering it mal-

* See first Bulletin of the National Institute, p. 51, Washington, D. C

leable, it is not always submitted to so many heatings and rollings. At Mr. Williams' works an engine of 96 horse power performs the necessary mechanical labor of the establishment. The smoke of all the furnaces is conducted by flues to a large, brick, arched trunk, or common recipient, which leads to a chimney about 70 feet high; this discharges the smoke and noxious vapors, and relieves the workmen from much of their baleful influence.

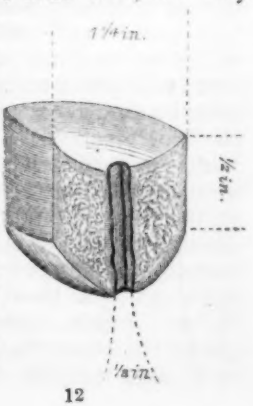
In the vicinity of the works, and, indeed, for miles round, there is scarcely the appearance of vegetation, and in many places not a trace of it can be seen. Every thing seems to droop and to die under the deleterious influences of the noxious gases emitted from the numerous furnaces; and where the surface of the ground was formerly covered with a rich sward, it is now furrowed by the action of the rains, and little, or nothing, can be made to grow on it. It is alike inimical to animal life. Horses and cattle are poisoned by it; their limbs become swollen; their eyesight defective; their teeth drop out; and they would soon die if they were not removed at the end of two years, when their places are supplied by other victims. It is not so fatal to human beings, as they only *breathe* the arsenic and sulphur, while the poor beasts *eat* those substances from the herbage on which they are deposited; but that it is extremely prejudicial to man, there can be no doubt, although he is certainly less affected by it than one might suppose. I always felt extremely uncomfortable after my visits to the works, and imagined myself pretty well poisoned; and, indeed, how could it well be otherwise, when the presence of arsenic, to say nothing of sulphur, was so perfectly obvious from its alliaceous smell? All suffer from it perceptibly, except the operators, who are so laboriously employed as to excite profuse perspiration, which relieves them, in a great measure, from its injurious action.

To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Explosion of Hardened Steel. *By* JOHN M. BATCHELDER.

It is well known that dies, and all articles of solid steel, are very liable to become fractured at the edges, if made too hard, but an actual explosion, as detailed below, is, I presume, of rare occurrence. The annexed figure represents a fragment of a step for an upright shaft, made of round steel $1\frac{3}{8}$th inch in diameter, with a hole $\frac{1}{4}$th of an inch in diameter, passing through the centre.



Twelve pieces were cut from the bar, and after being finished in the usual manner, were tempered separately, each being heated to a cherry-red heat, and plunged in water until perfectly cold; they were then laid aside, where the temperature was at sixty-five degrees. In about an hour, one of them burst

into two parts, with a report as loud as that of a pistol; one of the pieces was thrown about twelve feet, the other struck the wall of the shop two, or three, feet distant. Of the whole number made, eight were broken at intervals of several days, but without any violent explosion. Examined with the microscope, the steel appears distinctly radiated, or fibrous, to the depth of a line from the external surface, while the inside is granular, but without the slightest appearance of flaw, or want of actual contact of the particles at the point ruptured, previous to the explosion. The specific gravity of the bar-steel is 7.825; that of the fractured pieces 7.850.

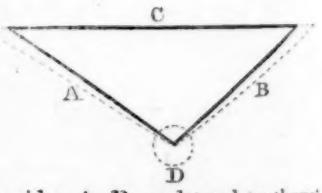
The cause of the fracture is, probably, the same as is observed in the glass toy called Prince Rupert's drops, made by pouring melted glass into cold water; the outside is suddenly contracted, while the particles in the interior, cooling more gradually, assume a different crystaline form, and burst asunder as soon as the cohesion of the external coating is destroyed.

TO THE COMMITTEE ON PUBLICATIONS OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

A Triangular Compensating Pendulum.

The problem of a compensating pendulum, made of a single piece of metal, occupied my attention several years ago: the subject passed from my memory, but was recently revived by looking over some old memoranda—a copy of one of which is subjoined. Besides other objections, an impression that an instrument, like the one proposed, would be of too awkward a shape to be adopted in practice, induced me to lay the project aside. The principle is, however, applicable to other matters; if, therefore, nothing of the kind has been suggested, and the idea be deemed sufficiently novel to be worth recording, you will, perhaps, give it a place in the Journal.

Let the distance from C to D, be the required length of a pendulum, C, being the point of suspension, and D, the oscillating body; it is required that the distance between them shall remain the same under all changes of temperature. Now, instead of directly connecting C, D, by a straight rod, (with the use of which the condition premised is incompatible,) let a triangle be formed as in the figure, of a piece of iron, steel, or other wire, of a uniform thickness and density. It is obvious



an increase of heat will lengthen the sides A, B, and tend to thrust D, further from C; but the side C, expanding at the same time, pushes the upper extremities of A, B, wider apart, (as represented by the dotted lines,) and, consequently,—if the length of C, be properly proportioned to A, B,—D, will remain at the same distance from C, as before. Again, suppose A, B, shortened by cold, the length of the pendulum is not effected, because the contraction of the side C, draws A, B, near together, and keeps D, where it was.

Hence it would seem that whatever variations of temperature may take place, such a pendulum, if correctly made, would be invariable. As the compensating property depends on the figure of the rod, no adjusting apparatus would be required. In simplicity, and other qualities, it surpasses the mercurial instrument of Graham, and the grid-iron of Harrison—that is, if the principle be found correct, and no mistakes in the inferences drawn from it. One striking defect, besides that of figure, is the want of stiffness, or rigidity, an important desideratum in a pendulum rod. The spring of the side C, might be fatal. To obviate this, in some measure, that side might be a flat bar, or the whole might be cut out of sheet metal, in which case the edges would oppose less resistance to the air. The position of the instrument, as shown in the figure, might be inverted—D, being made the point of suspension, and the weight placed at C.

Such is the memorandum referred to. If it be found of little worth, as regards the pendulum, it may, possibly, suggest, to some minds, more valuable speculation.

New York, July 5, 1844. T. E.

New Method of Preventing "Foaming" in Steam Boilers.

Notwithstanding the numerous schemes already before the public, intended to obviate the evils of priming, it would appear that they have not exhausted the remedial appliances within the compass of engineering skill. One mode of combating the evil has, within these few months, been patented by Mr. David Rapier, of Millwall, and another has been secured by registration, by Mr. John Allen, of London. Mr. David Napier's mode consists in covering the surface of the water in the boiler with hollow metallic balls—premising, however, that he does not confine himself exclusively to the use of balls, or to balls which have a less specific gravity than water; for other substances, even pebbles, may be employed, provided they are supported in the interior of the boiler by any mechanical means, as by wire gratings. Wood, he remarks, answers the purpose very well, and hollow glass balls would answer better, were it not that they are too fragile, when there is much ebullition. He, therefore, gives a preference to the metal balls, as they always tend to preserve the level, and present, at the same time, numerous and irregular interstices for the steam to pass through. The effect which the patentee expects to be produced by these balls, is, in the first place, to still the water, so as to prevent its rising up in quantities with the steam; and, in the next place, that the surfaces of the upper tier of balls will serve to intercept the smaller particles of water, and so allow the steam to blow off comparatively dry. Mr. Allen's mode of preventing foaming is different; the apparatus employed is a metal box, perforated with numerous small holes, which is to be attached to the receiving end of each pipe which leads from the boiler of a steam engine into the steam chest, and also to the receiving end of each pipe which leads from the steam chest into the engine cylinder. Both of these plans

appear to us simple and ingenious, and we have no doubts of their efficiency within certain limits. We may also observe that direct foaming is not the only evil encountered. When engines are worked by steam of two atmospheres, and upwards, no inconsiderable portion of the water is carried off with the steam in a state of minute subdivision, but still in the liquid condition; and, as it has no elasticity, and, therefore, produces no good effect, a serious loss of fuel is sustained, amounting, in the case of locomotive engines, on an average, to not less than a fourth of the whole. Any contrivance, therefore, by which this evil might be lessened, is worthy of consideration and fair experiment. Glasgow Prac. Mech. & Eng. Mag.

Iron Steam Vessels.

A singular calamity has just taken place, which recalls the speculations that endeavored to account for the melancholy fate of the President steamer; and having, unlike that ill fated vessel, left survivors to describe its events, at once gives a probable key to that dreary secret, and should furnish useful warnings for future application to the architecture of steam ships. The Elberfeldt Dutch steam vessel, on her way from Rotterdam to London, has been totally wrecked under novel and remarkable circumstances. "The Elberfeldt sailed from the Brielle on the 22d ult., under light and variable winds. Upon nearing the English coast, Mr. Bushe, a passenger, remarked that the ship's working appeared to be different from when they left Brielle, and that there was a strong vibration of the vessel. Scarcely had these remarks been made, when his suspicions were but too truly confirmed; he begged of Captain Stranach to order the boat to be in readiness, for he was convinced that the vessel, being constructed of iron, would afford but a few minutes to save themselves. While this conversation was taking place, an indication of a plain nature gave warning that their fears were well grounded; for about ten minutes to 3 P. M., she broke completely in half in the middle. Mr. Bushe rushed up stairs, and himself and two others fell headlong into the boat at the moment she was launched. Mr. Bushe then took the rudder of the boat, and kept her head to the wind as she was rowed, stern foremost, towards the vessel to save the remainder of the crew. This was a dreadful moment to all: the wreck presented a most awful, yet grand spectacle; the boiler, bursting by the collapse, threw up immense volumes of steam, and fountains of water, and the vessel went down with a loud explosion. The captain and several others were, with much difficulty, taken into the boat. Three persons were unfortunately lost. Captain Stranach and Mr. Bushe described the whole occurrence as a dream; for, from her breaking to her going down, not more than five minutes elapsed." In reading the story of this instant destruction, wherein the elements had no part, we almost feel as if we had got hold of some authentic narrative by which the mystery of the President was at length solved. Night,

and no survivor, and we have, again, the same wild catastrophe—most probably the same sad and strange tale in all its parts. At any rate, the construction of iron vessels, with their enormous weight of engines, coal, and water, amidships, is a subject which must be forced upon the naval architect; and *should* upon the government, by this direct and authentic evidence; and there are other questions connected with provision for the saving of crews and passengers in cases of shipwreck from other causes, happening to vessels made of iron, which should come, as morals, out of this interesting narrative.

Ibid.

Incrustration of Steam Boilers.

Sir,—I have seen several inquiries in your paper, as to the prevention of incrustration from lime in steam boilers. I am working three steam engines in limestone quarries, and have tried many experiments, having suffered much from this cause. Potatoes are efficacious, but animal matter of any kind much more so. I now use damaged sheep skins, or pelts, which cost me a mere trifle, and answer the purpose very effectually.

R. GREAVES.

Lond. Min. Journ.

List of American Patents which Expired in 1843.

Agriculture, improvements in	P. Pardee, Trenton, N. J.,	Feb. 6.
Anchors, faggoting	Tucker & Judge, Washington, D. C.,	Nov. 19.
Apple paring machine,	R. & A. Mosher, Galway, New York,	Dec. 31.
Apples, fruit, &c., preserving	A. Hart, Wharton township, Penn.,	Aug. 10.
——, grinding	D. D. Demarest, New Milford, N. Y.,	Jan. 11.
Augurs, hollow	A. Conent, Pepperville, Mass.,	June 11.
—— screw,	D. Bassett, Derby, Conn.,	March 18.
—— ——,	George Shetler, York, Penna.,	Sept. 10.
Axes, making	J. Allen, Sr., Pise, Indiana,	April 9.
Baker, economical	P. Wilcox, Springfield, Mass.,	Feb. 18.
Balance, dormant	J. K. Casey, New York, N. York,	Jan. 21.
Bedstead,	Rogers & Pearson, Essex co., Mass.,	June 11.
—— screw,	J. Copan, New York, N. York,	" 11.
Bell hanging,	J. Russell, " "	Oct. 16.
Bellows for foundries,	W. J. Jacks, " "	April 14.
—— tube,	A. A. McPharin, Huntingdon, Penna.,	June 11.
Bilgeways,	J. Thomas, New York, N. York,	Oct. 10.
Bitstock, composition	A. Phillips, Marlboro', Conn.,	" 10.
Blanks for checks, &c.,	J. Atwater, New Haven, Conn.,	Jan. 21.
——,	" " "	Aug. 18.
——,	Atwater & Jocelyns, New Haven, Ct.,	June 11.
Boats for canals,	T. W. Bakewell, Cincinnati, Ohio,	Aug. 25.
——,	B. Williams, Hartford, Conn.,	March 3.
Bobbins and flyers,	W. B. Taber, Canton, Mass.,	June 30.
Boiler, flat	Fanshaw & Hawks, New York, N. York,	" 11.
Boilers, &c., for anthracite,	J. Levatt, Philadelphia, Penn.,	March 17.
——, constructing	J. Hurd, jr., Boston, Mass.,	Nov. 10.
Bolting flour, &c.,	W. A. Aikens, Berkshire, New York,	Dec. 3.
Book-binding,	J. Torry, Germantown, Penn.,	Aug. 8.

Boot crimper,	T. Howe, Worcester, Mass.,	June 11.
—— manufacture,	A. Burdick, Carroll, N. York,	Oct. 31.
Boots, measuring for, &c.,	T. Howe, Worcester, Mass.,	April 18.
—— and shoes, cutting	S. Marshall, Philadelphia, Penn.,	June 23.
————, pegging	N. Leonard, Merrimac, N. Hampshire,	" 11.
————, polished	Ryan, Haskens & Known, Boston, Mass.,	Sept. 23.
Boxes for machinery,	S. Reynolds, Guildford, New York,	June 13.
Bricks, burning	Adams & Noyes, Newburgh, N. York,	Dec. 28.
Brick machine,	J. S. Hanna, Mercer, Penn.,	Nov. 23.
—— press,	J. Woodson, Rockbridge co., Va.,	Sept. 10.
—— and tile machine,	J. Wood, Rockland co., N. York,	March 3.
Bridges,	L. Wernwag, Jefferson co., Penn.	Dec. 22.
Brushes, manufacturing	D. Wooster, China, New York,	Sept. 10.
Bulk-heads for steamboats,	R. Whiting, Louisville, Kentucky,	June 6.
Buttons, steel dies for	W. Robinson, Attleboro', Mass.,	March 3.
Canal and other boats,	L. D. Burnet, Butternuts, N. York,	June 30.
—— excavating,	G. Hendricks, Urbanna, Ohio,	Aug. 5.
—— locks,	J. White, Philadelphia, Penna.,	June 11.
—— passages for boats,	J. Bromwell, Cincinnati, Ohio,	" 23.
Carding wool,	J. Baynton, South Coventry, Conn.,	April 11.
Carpeting, felt	A. Byington, Herkimer, New York,	May 6.
————, woolen	W. Harrington, Harrison, New York,	March 3.
————, ——	" " "	June 11.
Carriage, double axletree	E. G. Fitch, Blakely, Alabama,	Feb. 7.
———— for heavy bodies,	E. Bowen, Ledyard, New York,	April 9.
Carriages, propelling	M. F. Colborn, Baltimore, Maryland,	" 7.
Casks, making, by steam,	J. Thompson, Philadelphia, Penn.,	Dec. 30.
Cement, &c., water-proof	Howe & Haywood, New York, N. York,	Jan. 31.
Chain wheel,	Hines & McCord, Sandy Hill, "	Nov. 20.
Chandeliers of salt,	F. B. Merrill, Buffalo, New York,	June 15.
Charcoal, manufacturing	J. Doolittle, Bennington, Vermont,	Dec. 14.
Cheese curd,	A. Morris, Sacketts Harbor, New York,	May 2.
—— press,	R. McOmber, Galway, "	Oct. 27.
Chimnies, cleaning	S. Dow, Elizabethboro', New Jersey,	June 1.
————, curing smoky,	A. H. Reed, Montrose, Penna.,	April 3.
————, iron coping for	E. Neer, Waterford, New York,	Sept. 11.
Churn,	J. C. Barrett, Collins, "	Oct. 19.
——,	W. Cook, South Port, "	Dec. 7.
——,	B. Cushwa, Clear Spring, Maryland,	Jan. 24.
——,	" " "	Dec. 3.
——,	Z. Doty, Groton, New York,	March 17.
——,	C. Foss, Perry, Ohio,	June 11.
——,	H. H. Grover, Auburn, New York,	Nov. 30.
——,	T. & L. Morrison, Groton, "	Oct. 16.
——,	A. Murray, Athens, "	Jan. 27.
——,	S. J. O'Brien, New York, New York,	June 22.
Cider mill,	M. B. Bliss, Pittston, Maine,	April 21.
————,	T. Quintard, Stanton, Conn.,	March 3.
———— and press,	U. Emmons, New York, N. York,	Jan. 31.
————————,	D. Pride, Potsdam, "	June 11.
————————,	D. Reed, Stanton, Conn.,	March 3.
Clay and sand, grinding,	A. Cushman, Sumner, Maine,	" 3.
Clock, self-moving,	R. Ward, Waterbury, Conn.,	Nov. 5.
Cloth, cutting	L. P. Lemont, Bath, Maine,	Jan. 9.
——, making	H. Raymond, New York, New York,	June 27.
——, napping	Norris & Phillips, Covington, N. Jersey,	March 22.
——, washing, &c.,	H. Slayton, Lockport, New York,	Nov. 25
—— without bleaching,	Peck & Taylor, Fairfield co., Conn.,	June 27.
Coffee mills,	J. Carrington, Wallingford, Conn.,	Aug. 3.
Combs,	E. Mustin, Philadelphia, Penna.,	June 27.
——, forming, &c.,	S. Lambert, Hanover co., Virginia,	Jan. 19.

Combs, making	E. Sperry, New Haven, Conn.,	Oct. 10.
—— manufacture,	J. Brown, Providence, Rhode Island,	June 11.
——, rubbing and polishing	Prindle & Curtis, Newton, Conn.,	Oct. 10.
——, &c., from raw hides,	S. Pike, Providence, Ohio,	June 11.
Commode knobs, glass	E. Skinner, Sandwich, N, Hampshire,	June 11.
Cook, economical	J. Hess, Philadelphia, Penna.,	March 9.
Cooking,	P. A. Sanborn, Troy, New York,	July 11.
Cooper's work, making	N. Rider, Starbridge, Mass.,	April 1.
Corn planting,	Lenox, Croft & Pitner, Steubenville, O.,	Jan. 26.
—— sheller,	J. S. Gardiner, Canandiagua, N. York,	June 11.
Cotton cleaner,	A. Gillman, Reedy Fork, S. Carolina,	Oct. 10.
—— gin,	S. T. Conn, New York, N. York,	Jan. 11.
——,	D. Phillips, Jefferson co., Va.,	April 3.
—— packing,	O. Stith, Lawrenceville, Va.,	Aug. 25.
—— press,	Z. Bronson, Jasper, Georgia,	July 7.
—— ——,	P. Payne, Claiborne, co., Mississippi,	Aug. 10.
—— seed separator,	F. Follet, Petersburg, Virginia,	Jan. 21.
——,	F. Follett, Petersburgh, Virginia,	Dec. 16.
—— separating,	J. Smith, " "	" 28.
Cradle, self-moving	A. Buckenburger, New York, N. York,	Nov. 3.
Cultivator, tooth	J. Cobb, Westminster, Vermont,	Dec. 7.
Dams, for passage of fish up	P. Magrath, Philadelphia, Penn.,	Oct. 10.
Distillery,	Wm. Cooke, South Port, New York,	Dec. 7.
Distilling, maize	A. Doolittle, Michigan Territory,	Nov. 16.
Dock, dry	E. Seldon, Haddam, Conn.,	July 30.
——, screw	J. C. Ely, New York, N. York,	Jan. 28.
——, ——	E. Turner, Rochester, "	Oct. 10.
Doffer for carding,	C. Alwood, Middletown, Conn.,	April 18.
Door fender,	Cole & Johnson, Rudolph, Mass.,	March 27.
—— spring,	L. Burnet, Berlin, Conn.,	Nov. 25.
—— and windows, tightening	S. Haywood, Plainfield, Mass.,	Oct. 17.
Drums, soldering factory	L. N. Perry, Worcester, "	Jan. 23.
Dyeing by steam,	R. Wood, Erie, New York,	Aug. 25.
Fan wheel, thrashing	G. Hoffman, Fredericktown, Md.,	Aug. 21.
Fanning mill,	J. Frary, Southampton, Mass.,	Feb. 17.
Feather cleaning,	C. Toupet, New York, N. York,	Oct. 15.
Felloes, bending, by steam,	M. Blakeslee, Canaan, Conn.,	July 29.
Felt machine,	Baker & Kinsley, Green co., New York,	Aug. 29.
—— of wool,	L. Van Hoesen, jr., Norwalk, Conn.,	June 27.
Felting and fulling machine,	Longbury, Arnold & Co., Norwalk, Conn.	July 15.
Files, renewing old	A. P. & E. Brittingham, N. York, N. Y.,	" 27.
Filtering machine,	G. B. White, " " "	" 7.
Fire arms,	H. Rogers, Middletown, Penna.,	May 7.
——,	J. Shaw, Philadelphia, "	" 7.
——, discharging	R. Eastman, Brunswick, Maine,	Dec. 7.
Fire and light, producing	J. Jennings, New York, New York,	June 11.
Flax and hemp machine,	Barnum & Stevenson, Cambridge, N. Y.,	July 8.
——,	T. Cohoon, Troy, "	April 25.
——,	T. F. L. Roumage, New York, "	Aug. 6.
——,	A. Salesbury, Troy, "	April 15.
——,	Salesbury & Longdon, Troy, "	" 18.
——,	" " " "	July 8.
——,	L. Tibbitt, New Glasgow, Virginia,	Aug. 1.
——,	Watson, Blosson & Barnut, Salem, N. Y.,	April 21.
——,	R. Medley, Bloomfield, Kentucky,	June 11.
Flies, machine for killing	A. Glendenning, Loudon co., Virginia,	Sept. 9.
Fly net for horses,	H. Korn, Philadelphia, Penn.,	" 12.
Fork, four tined	C. Perkins, Waterbury, Conn.,	Jan. 27.
Friction wheels for railroad carriages,	H. B. Chew, Baltimore, Md.,	April 9.
Furnace and oven, cooking	L. V. Badger, Dover, New Hampshire,	Jan. 30.
—— with reflectors,	J. Hurd, jr., Boston, Mass.,	Nov. 10.

Furrowing machine and corn dropper,	M. & J. Nichols, Otsego, New York,	Oct. 12.
Garments, for cutting	O. Madison, Troy, New York,	Aug. 18.
Gauge for saw sett,	J. Hatch, Westford, Vermont,	Oct. 12.
Glass chimnies for lamps,	J. Jenning, New York, New York,	March 3.
—— knobs and screws,	D. Jarvis, Boston, Mass.,	June 15.
—— clock wheels,	T. & J. P. Bakewell, Pittsburgh, Penna.,	Jan. 14.
Gold washing,	W. H. Falger, Charlotte, N. Carolina,	Sept. 10.
————,	" " "	Nov. 18
————,	R. Lee, Erwinsville, "	July 8.
Grates, cooking	T. Vinton, Philadelphia, Penna.,	Oct. 31.
Gridiron,	J. Powers, Lansingburg, New York,	Aug. 10.
Grinding grain and paints,	H. Averill, Richland, "	April 30.
Grist mill,	T. Baker, Statesburg, S. Carolina,	Jan. 21.
————.	M. L. Chase, Frankford, Maine,	Dec. 23.
————,	B. M. Kemp, Fort Plain, New York,	Jan. 31.
————,	W. Parkinson, Wheeling, Virginia,	July 31.
————,	A. Temple, Brookfield, Ohio,	Dec. 11.
————,	Wickersham & Crozer, East Fairfield,	Aug. 29.
Guide boards,	S. Carter, Raymond, Mass.,	Nov. 25.
Gun lock,	E. Gilbert, Rochester, New York,	April 3.
——, percussion eight barrel	S. L. Faries, Middletown, Ohio,	Oct. 10.
Guns, elevating heavy	W. H. Bell, Fortress Monroe, Virginia,	Dec. 8.
Hammers for nails,	C. A. Strong, South Glastonbury, Conn.,	March 3.
————, hanging forge	J. McNeal, Coleman township, Penna.,	Jan. 21.
Harness, trimmings, &c.	W. S. Robinson, Taunton, Mass.,	Sept. 2.
Harpoon,	J. Sizer, New London, Connecticut,	Oct. 16.
Hat bodies,	Clark & Chase, Falmouth, Mass.,	June 11.
————,	Lapham & Cady, Canaan, New York,	April 15.
————,	O. Rust, Montgomery co., "	Dec. 19.
————,	L. Van Hoesen, Norwich, Conn.,	June 19.
—— stiffening,	J. D. Wilson, New York, N. York,	Jan. 6.
Hats, napping	D. Baldwin, Ithaca, "	Oct. 15.
Heater, cylindrical air	C. Fowler, Hartford, Conn.,	July 10.
Heckling, hair, machine	W. Chubb, New York, N. York,	" 9.
Hoes,	G. Freeborn, " "	" 7.
——,	J. Watson, Canaan, Conn.,	" 26.
House, covering with tin plate, &c.,	R. S. Tilden, Lynchburg, Virginia,	Sept. 10.
Hubs.	H. Thomas, Middleboro', Mass.,	" 11.
Hulling rice and coffee,	Z. Bronson, Jasper, Georgia,	July 7.
Hydrostatic press,	Mason & Baldwin, Philadelphia, Penna.,	Dec. 2.
Ice cutting machine,	N. J. Wyeth, Cambridge, Mass.,	March 18.
————————,	" " "	" 18.
Incline planes for canal boats,	E. Morris, Bloomfield, Penn.,	Oct. 13.
Ink distributor,	J. Prince, New York, N. York,	Dec. 3.
Inking apparatus, gravitating	W. J. Stone, Washington, D. C.,	Oct. 20.
Jackscrew,	T. Evans, New York, N. York,	Feb. 16.
Knife Renovator,	I. Jennings, New York, N. York,	March 17.
—— sharpener,	W. J. Dunn, " "	Aug. 18.
————,	W. Hunt, " "	Feb. 19.
Lamp,	I. Jennings, New York, N. York,	Sept. 10.
Lamps, and economy of light,	" " "	June 11.
————, and ingredients for burning,	" " "	March 3.
Lathe, turning	E. Putnam, Gardiner, Maine,	Dec. 9.
Lecktography,	J. B. Manning, Gloucester, Mass.,	Feb. 16.
Lever press, compound	J. Rogers, Maury co., Tennessee,	Jan. 21.
Lime, hydraulic	R. Leckie, Washington, D. C.,	March 31.
—— kiln,	L. Bomeisler, Philadelphia, Penn.,	Sept. 10.

Locks,	T. Bartholemew, New York, N. York,	April 3.
——, mortise and door	T. Whitehouse, Boston, Mass.,	Sept. 29.
Locomotive for incline planes,	S. Olcott, Harsimus, New Jersey,	" 11.
Loom for figured cloth,	W. Levelly, Canterbury, Conn.,	March 20.
Loom, power	A. Stone, Providence, R. Island,	April 30.
Lotteries, drawing	D. Malcolm, New Orleans, Louisiana,	July 30.
Metals and ores, fusing	Chew & Freeman, Baltimore, Md.,	April 7.
Milk, drawing from the breast,	Houghtaling & Maneely, Watervleit, N.Y.	June 11.
Mill, iron	C. & J. W. Post, Washington, D. C.,	April 11.
—— machinery, propelling	B. S. Ridgeway, Charleston, S. Carolina,	Feb. 6.
—— stone,	D. Phillips, Jefferson co., Miss.,	April 3.
Milling,	J. Reeder, Lebanon, Ohio,	Oct. 31.
Mortising, sawing and boring,	R. Medley, Bloomfield, Kentucky,	July 7.
——— and tenoning,	L. Davis, Northampton, Mass.,	April 14.
Mud machine,	J. Newman, Providence, Rhode Island,	June 27.
Mule, self operating	J. Gay, Dunstable, N. Hampshire.	April 10.
Music notes,	W. C. Phillips, Lunenburg, Va.,	June 18.
Muskets, with several charges,	J. Miller, Brighton, New York,	" 11.
Nail machine,	T. Odiorne, Morgan, Mass.,	April 3.
—— and rivet manufacture,	S. G. Reynolds, Bristol, R. Island,	" 13.
——, wrought	S. Davis, Dartmouth, Mass.,	Dec. 8.
—— and screw machine,	S. Gould, jr., Litchfield, Conn.,	July 25.
Nap on cloth, raising	Z. Allen, Providence, R. Island,	Aug. 10.
Navigation, improvement in	A. Heilbrown, New York, N. Y.,	March 6.
Oil in paint, substitute for	L. J. Van Kleek, Poughkeepsie, N. Y.,	Nov. 23.
——, refining	C. E. Ruggles, New York, "	July 20.
Ovens with reflectors,	J. Hurd, jr., Boston, Mass.,	Nov. 10.
Paddle wheels,	J. Perkins, London, England,	Nov. 30.
Packing machine,	T. Jennings, Statesbury, S. Carolina,	March 3.
Paint mill,	S. Cook, Whitestown, N. York,	" 30.
Pan for salt water,	Blockson & Fracker, Zanesville, Ohio,	" 23.
Paper from rags,	J. W. Cooper, Washington township, Pa.,	Feb. 7.
—— manufacturing,	R. Fairchild, Trumbull, Conn.,	May 4.
—— machine, cylindrical	J. Sanderson, Milton, Mass.,	April 18.
Pegs for shoes,	S. S. & E. Beckwith, Westmorel'd, N.Y.	June 27.
Pencil case, ever pointed	W. Jackson, Philadelphia, Penn.,	July 27.
———, ———	J. Saxton, " "	April 11.
Perambulator,	A. Gifford, West Point, N. York,	Oct. 27.
Pianos, instruments for tuning	P. Pettinos, Philadelphia, Penn.,	March 3.
Picture frames,	Parker & Clover, New York, N. Y.,	" 23.
Plane, groove	Lonanecker & Myers, Lancaster, Penn.,	Feb. 7.
Planing engine, circular	U. Emmons, New York, N. Y.,	Sept. 10.
——— and groving,	C. Taylor, Angola, "	Feb. 7.
——— machine, cylindrical	U. Emmons, New York, "	April 25.
Planks, sawing logs into	P. Tomlinson, Derby, Conn.,	" 3.
Planting machine,	Z. Lane, Harrisburg, N. York,	Sept. 21.
Plough,	J. Boatwright, Columbia, S. Carolina,	June 11.
———,	T. Brown, New York, N. York,	Sept. 11.
———,	T. Miller, Pittsburgh, Penn.,	Oct. 23.
———,	J. Rhodes, Urbana, Ohio,	June 11.
———, bogging and ditching	J. Gordon, Copeck, New York,	Jan. 13.
———, cast iron	J. Minturn, Urbana, Ohio,	June 11.
———, double	Medley & Altendeffer, Cootstown, Pa.,	June 11.
———, iron	J. Boynton, South Coventry, Conn.,	July 10.
Power machine,	W. Harford, jr., Washington township, O.,	Dec. 31.
—— to machinery,	R. Mitchell, Cynthiana, Kentucky,	Oct. 10.
Pressing and raising weights,	T. Cumming, Mayville, N. York,	Feb. 19.
Printing press,	S. Rust, New York, "	April 17.

Printing press,	J. J. Wells, Hartford, Conn.,	April 3.
Propelling boats,	B. M. Small, Rochester, N. York,	Nov. 20.
Pump,	J. W. Hillias, Baltimore, Md.,	Sept. 16.
—— buckets,	D. Coon, Menden, N. York,	Nov. 28.
Pumps,	R. Wileman, East Hartford, Conn.,	July 9.
——— for ships,	J. B. Pell, New York, N. York,	Oct. 31.
———, working ships',	M. Francis, Boston, Mass.,	July 7.
Punch, power press	G. Darracott, " "	July 21.
Rags, cleaning	W. Debit, East Hartford, Conn.,	Jan. 13.
Rail roads and cars,	J. Wright, Columbia, Penna.,	April 17.
——————— carriages,	J. Knight, Baltimore, Md.,	June 11.
———————, improvements in	J. Wright, Columbia, Penn.,	" 11.
Railway carriage,	J. J. Reckert, Baltimore, Md.,	Dec. 11.
———————,	J. L. Sullivan, Philadelphia, Penn.,	April 6.
———————, cylindrical,	P. Flemming, Albany, New York,	May 4.
———————————,	H. Finley, Baltimore, Md.,	Oct. 27.
———————————,	J. Knight, " "	March 18.
——— ———, self adjusting	J. Wright, Columbia, Pa.,	March 17.
Razor strops,	J. W. Osborne, Terre Haute, Indiana,	Jan. 21.
———————,	G. Halloway, Chester, Ohio,	April 3.
Rectifying spirits by distillation,	R. Mauck, Galliopolis, "	Dec. 7.
Reeding and fluting, machine for	J. January, Greenville, Kentucky,	March 3.
Rice mill,	A. Nourse, Charleston, S. Carolina,	Sept. 3.
Roofs for buildings,	Nathan Adams, Marlboro', N. York,	July 29.
Rope making,	S. Hills, jr., Glastonbury, Conn.	June 11.
Rotary motion by steam,	J. Mount, Nashville, Tennessee,	July 16.
——— steam engine,	Lee & Stewart, Philadelphia, Penn.,	June 11.
Salt for lye,	S. H. Bergen, Philadelphia, Penna.,	April 3.
—— manufacture,	A. Brown, Salina, N. York,	June 11.
———— ———,	T. A. Teissier, Boston, Mass.,	Jan. 13.
————————,	" " "	April 11.
—— manufacturing,	E. Wade, Elizabethtown, New Jersey,	June 26.
Sausage machine,	T. Howe, Spencer, Mass.,	Feb. 19.
Saw circular, revolving	H. J. Tudor, Boston, Mass.-	April 29.
Saws, hanging and straining	L. Chapin, Walpole, New Hampshire,	Oct. 13.
Saw mill,	George Brown, Deerfield, N. York,	April 7.
———,	J. Johnson, jr., Moriah, "	May 7.
———, floating	J. C. Ely, N. York, "	Oct. 21.
——, vencering	A. F. Smith, Salem, Mass.,	Sept. 10.
Sawing trees,	D. Pierce, Poughkeepsie, N. York,	April 3.
Scraper, metallic	O. Teall, Salina, "	Dec. 9.
Screen, fire	C. Pierce, Salem, Mass.,	April 29.
Scythes, rifle for sharpening	B. Swift, Washington, New York,	June 11.
Shears, &c., for cloth shearing	S. A. Britt, Cozanovia, "	Aug. 10.
Shearing, woolen cloth	M. Hurd, Augusta, "	Dec. 7.
Shingle machine,	J. Barns. Cornwall Bridge, Conn.,	Oct. 10.
———————,	J. W. Johnson, Fredonia, New York,	May 7.
———————,	P. Jones, James City co., Virginia,	Nov. 12.
———————,	R. McOmbre, Galway, New York,	Oct. 10.
———————,	S. Wood, Holden, Mass.,	Nov. 10.
Ships, to ascertain the velocity of	J. D. Woodsides, Washington, D. C.,	March 17.
Sifting grain, flour, &c.,	J. Nichols, Boston, Mass.,	April 29.
Spade, pronged	Wm. B. Horton, Middletown, Conn.,	June 15.
Spectacles, spiral spring	S. Babcock, Middletown, Conn.,	April 3.
Speeder,	G. Brewster, Poughkeepsie, N. York,	" 18.
Spikes, bolts, &c., pattern for mould'g	J. & C. Sewall, Bath, Maine,	March 25.
Spinning Silk, Cotton, &c.,	G. Addison & L. H. Stearns, N.York, N.Y.	Oct. 10.
——— hemp, flax, &c.,	W. Hunt, " "	June 11.
——— wool, &c., apparatus for	Warren Allen, New Haven, Conn.,	Aug. 15.
——— and cotton by hand,	N. Harris, Fairfield co., Ohio,	Jan. 21.
Spinner, cap	John Thorp, Providence, R. Island,	" 23.
———, golden	J. B. Wheeler, Galway, New York,	Dec. 30.

Spinner, improvement on	J. Thorp, Providence, R. Island,	April 3.
——, running cap	" " "	June 13.
Splints for fractured limbs,	D. S. & C. H. Smith, Sutton, Mass.,	Sept. 10.
Spring seats for carriages,	S. Reynolds, New York, N. York,	Nov. 20.
Staging swing,	E. Drury, Washington, Mass..	Feb. 16.
Stave dressing,	C. B. Goodrich, Rutland, Mass.,	" 3.
—— dresser,	" " "	" 4.
Steam boilers,	Coffin & Beach, Boston, Mass.,	June 29.
—— engines,	M. Battle, Albany, New York,	Nov. 6.
—— engine, hydraulic	J. Cutlin, Cincinnati, Ohio,	Jan. 11.
——, atmospheric	Mead & Kitchell, Lebanon, Ohio,	Feb. 27.
——, avoiding dead point,	V. Carter, Georgetown, D. C.,	Aug. 3.
——, rotary	J. Woodhull, Rochester, N. York,	April 6.
——, use and application of,	Packard & Strong, Granville, N. York,	Aug. 7.
Steel from wrought iron	S. Pope, New York, N. York,	Nov. 20.
Stereotype plates,	N. Hall, Boston, Mass.,	" 20.
Steering ships, &c.	M. Pierson, Newburyport, Mass.,	April 1.
Stocks, gentlemen's	G. R. Lillebridge, New York, N. York,	Oct. 10.
Stove, air furnace oven	O. Davidson, Johnstown, "	Aug. 25.
——, cooking	C. Schemerhorn, New York, "	June 23.
——, ——	John Hurd, jr., Boston, Mass.,	Nov. 10.
——, ——	P. Williamson, Philadelphia, Penn.,	Feb. 16.
——, ——	G. Richards, Povidence, R. Island,	Sept. 9.
——, ——	W. Naylor, New York, N. Y.,	June 11.
——, ——	A. J. Barnett, Louisville, Kentucky,	Oct. 19.
——, ——	E. E. Bennett, Sandy Hill, New York,	July 17.
——, double furnace	J. Richards, Claremont, N. Hampshire,	Aug. 5.
Straps, punching	Charles Angell, Philadelphia, Penn.,	July 15.
Straw cutter,	L. Rice, Lockport, New York,	April 1.
Sugar breaking machine,	W. G. Sterling, Bridgeport, Conn.,	Jan. 28.
—— from cane juice,	E. A. Lester, Boston, Mass.,	Sept. 10.
Tables for drying tobacco,	G. Gampbell, Schenectady, New York,	Jan. 7.
Tanning and tan yard,	L. B. Johnson, Tomkinsville, Kentucky,	March 3.
Teeth, composition for	T. White, St. Clairsville, Ohio,	July 29.
—— extractor,	E. Bryan, New York, N. York,	" 13.
Temples, rotary	J. Draper, Saugus, Mass.,	April 1.
Tide power,	H. P. Weston, New York, N. York,	Dec. 23.
—— and current mill,	J. Wallace, Hartford, Kentucky,	Sept. 1.
Tin ware,	A. Hubbard, Claremont, N. Hampshire,	Nov. 12.
Thrashing machine,	W. Barnes, Brookhaven, N. York,	Dec. 14.
——,	C. Emmons, New York, "	July 27.
——,	G. Fuller, Gardiner, Maine,	June 11.
——,	E. Harman, Upper Wakefield, Pa.,	Aug. 5.
——,	J. Haws, Hudson, N. York,	Dec. 31.
——,	T. G. Owen, Baltimore, Maryland,	Nov. 26.
——,	J. S. Wood, Botetourt co., Va.,	Jan. 9.
——,	J. S. Wood, Pattensburg, "	Sept. 10.
Throstle frames,	H. Ruggles, New York, N. York,	Nov. 24.
—— for spinning cotton,	S. Blydenburg, " "	" 10.
Toothache specific,	S. Pennington, Mount Pleasant, Ohio,	July 30.
——,	S. Prescott, " "	" 30.
Tow lines for canal boats,	James Sandford, Weston, Conn.,	Feb. 16.
Tripp hammer,	S. Kilburn, Sterling, Md.,	Aug. 8.
Truss,	A. G. Hull, New York, N. York,	Oct. 28.
Twine machine,	A. Pond, Petersburgh, Virginia,	April 21.
Typography,	W. A. Burt, Detroit, Michigan,	July 23.
Tire hoops, bending	J. Butler, Cobleskill, "	Sept. 24.
Veneers, cutting	C. B. Burnap, Belfast, Maine,	May 1.
——, splitting tenons and	J. McClintic, Chambersburg, Penn.,	April 21.
Veneer and panel cutting	White & Quimby, Belfast, Maine,	Sept. 12.

Wafers, &c., cutting	E. M. Ely, Paris, France,	Jan. 28.
Wagons, raising and lowering	T. Scott, London, Penn.,	March 3
Washing and churning machine,	J. B. Pratt, Milo, New York,	July 14.
———————————,	F. Reed, Pike township, Penna.,	June 11.
———————————,	G. B. Gibbs, Le Roysville "	Oct. 10.
——— machine,	R. Mosher, Galway, New York,	Jan. 8.
———————,	C. D. Wright, East Haddam, Conn.,	Nov. 19.
———————,	E. Wheeler, Galway, New York,	June 11.
———————,	J. Taylor, Dunstable, N. Hampshire,	April 1.
———————,	Schiveler, McEwer & Lindsey, Fredericksburgh, Ohio,	Oct. 21.
———————,	W. E. Arnold, Haddam, Conn.,	Aug. 3.
———————,	R. Brainard, " "	Nov. 23.
———————,	E. Berrey, New York, N. York,	May 12.
———————,	E. D. Cherry, Auburn, "	Sept. 10.
———————,	J. T. U. Dennis, Painesville, Ohio,	Dec. 16.
———————,	S. Hind, Montrose, Penn.,	April 25.
———————,	A. Larcom, Watervleit, New York,	Jan. 16.
———————,	P. Mosher, Ballston Spa, "	Oct. 10.
Water, drawing from forebays, &c.,	Espy & Young, Philadelphia, Penn.,	Sept. 11.
———, raising	Lazell & Bloodgood, Poughkeepsie, N.Y.,	July 27.
———, ——–, from wells,	S. Smith, Mendon, N. York,	March 17.
———, ———, by atmospheric	S. McClure, Wilmington, Ohio,	Aug. 25.
——— wheel,	E. Bryan, New York, N. York,	April 8.
——— wheels, supplying water to ——————— for boats and mills,	J. Houghton, Greene co., Georgia,	June 13.
	P. Baynton, Ogdensburgh, N. York,	April 21.
——— and paddle wheels,	B. Howard, Worcester, Mass.,	June 11.
Weaving narrow stuff,	J. Thorp, Providence, R. Island,	Dec. 22.
Webb of cloth, forming	John Arnold, Norwalk, Conn.,	July 15.
Weighing goods on board of boats,	T. Cohoon, Troy, New York,	June 18.
Wheel, current and tide	A. Madison, Detroit, Michigan,	July 10.
———, inside lever propeller,	J. H. Green, Baltimore, Maryland,	Dec. 1.
———————— ———,	J. J. Giraud, " "	" 1.
——— and rest,	J. Johnson, jr., Moriah, New York,	May 1.
Wheels,	J. G. Bridgman, New Haven, Conn.,	July 16.
White lead,	John Burney, N. Haven township, Ohio,	Jan. 2.
———,	" " " "	" 2.
Wind mill,	D. McColler, Ballston Spa, N. York,	Oct. 10.
Window shutters, securing	T. Bartholemew, N. York, "	June 30.
Winnowing and threshing machine,	Davis & Carey, Riga, "	" 11.
Windlass, power	W. Pennell, Brunswick, Maine,	" 29.
Wire nets and fences,	C. Hall, Meriden, Conn.,	Nov. 27.
Wooden combs,	N. Bushnell, Middlesex, Conn.,	April 14.
Wool, &c., manufacturing	J. Goulding, Dedham, Mass.,	Feb. 16.
———————,	" " "	" 16.
———————,	" " "	June 11.
———————,	" " "	July 12.
———, spinning	J. Orndoff, Russellville, Kentucky,	Nov. 10.
——— carding machine,	J. W. Shanklin, Summerfield, Ohio,	May 5.
Yarn, roll on shuttle,	J. Thorp, Providence, Rhode Island,	March 20.